

AD-A078 970

BAKER (MICHAEL) JR INC BEAVER PA

F/G 13/13

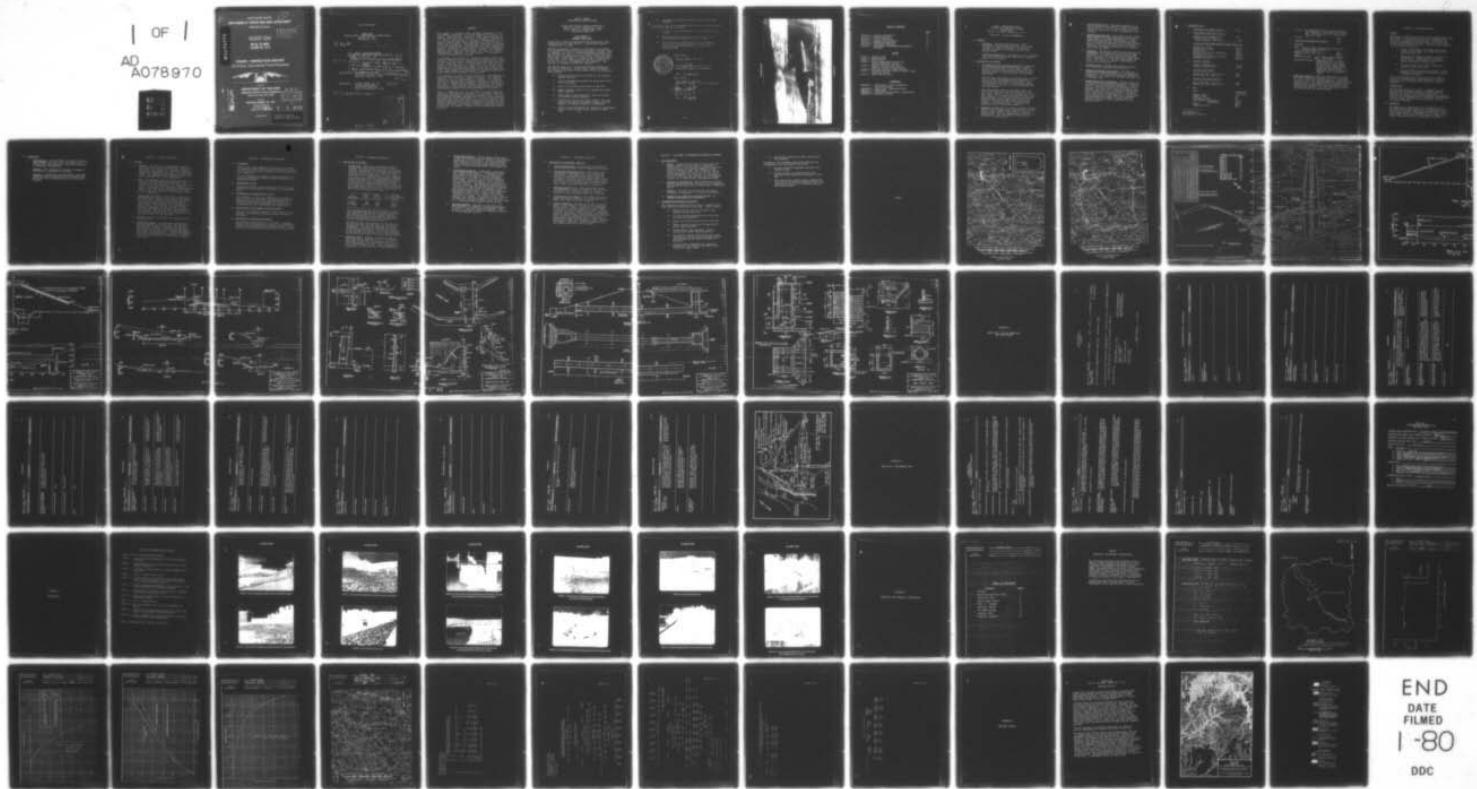
NATIONAL DAM SAFETY PROGRAM, GLADES DAM (NDI NUMBER PA-00804, P--ETC(U)

DACW31-79-C-0011

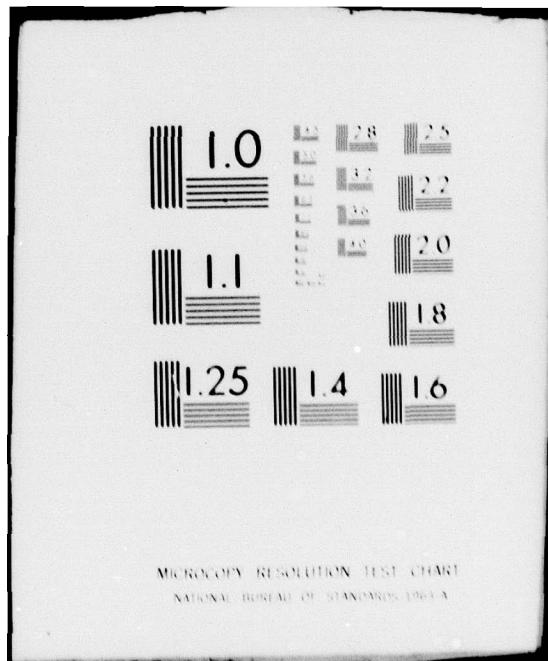
NL

UNCLASSIFIED

| OF |  
AD  
A078970



END  
DATE  
FILED  
I-80  
DDC



8  
AD A078970

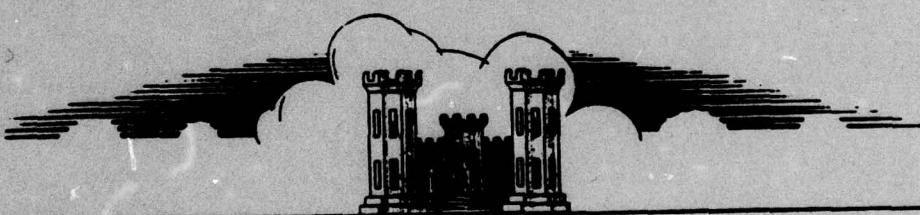
OHIO RIVER BASIN  
SOUTH BRANCH OF SLIPPERY ROCK CREEK, BUTLER COUNTY  
PENNSYLVANIA

GLADES DAM

NDI No. PA 00804  
PennDER No. 10-72

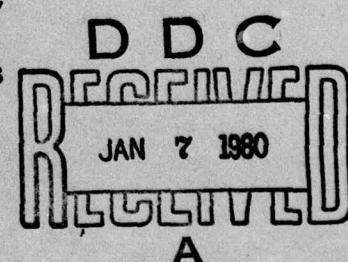
0  
LEVEL H

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM



prepared for

DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203



prepared by  
MICHAEL BAKER, JR., INC.

Consulting Engineers  
4301 Dutch Ridge Road  
Beaver, Pennsylvania 15009

7 1 018

DDC FILE COPY

AUGUST 1979

Distribution Unlimited  
Approved for Public Release  
Contract No. DACW31-79-C-0011

OHIO RIVER BASIN

GLADES DAM  
BUTLER COUNTY, COMMONWEALTH OF PENNSYLVANIA  
NDI No. PA 00804  
PennDER No. 10-72

11 Aug 79

10 Chuan Yuan/Chen

6 PHASE I INSPECTION REPORT  
NATIONAL DAM SAFETY PROGRAM. Glades Dam  
NDI PA-00804, PennDER 10-72, Ohio  
River Basin, South Branch of  
Slippery Rock Creek, Butler County,  
Pennsylvania. Phase I Inspection

Prepared for: DEPARTMENT OF THE ARMY  
Baltimore District, Corps of Engineers  
Baltimore, Maryland 21203 Report,

Prepared by: MICHAEL BAKER, JR., INC.  
Consulting Engineers  
4301 Dutch Ridge Road  
Beaver, Pennsylvania 15009

15 DATW32-79-2-0011

Accession For	
NTIS GRA&I	
DDC TAB	
Unclassified	
Justification	
Fy	
Distribution	
Availability Codes	
Dist	Avail and/or special

410 795

SLT

## PREFACE

This report is prepared under guidance contained in the "Recommended Guidelines for Safety Inspection of Dams," for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I Inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT  
NATIONAL DAM SAFETY PROGRAM

Glades Dam, Butler County, Pennsylvania  
NDI No. PA 00804, PennDER No. 10-72  
South Branch of Slippery Rock Creek  
Inspected 11 May 1979

ASSESSMENT OF  
GENERAL CONDITIONS

Glades Dam is owned and operated by the Pennsylvania Game Commission and is classified as a "Significant" hazard- "Intermediate" size dam.

Hydraulic/hydrologic evaluations, performed in accordance with procedures established by the Baltimore District, Corps of Engineers, for Phase I Inspection Reports, revealed that the spillway will pass the 1/2 Probable Maximum Flood (1/2 PMF) without overtopping the dam. (Note: A spillway design flood (SDF) in the range of 1/2 PMF to PMF is required for Glades Dam. The 1/2 PMF was chosen because the dam is on the low side of the "Intermediate" size category.) The spillway is therefore considered "adequate."

The dam was found to be in very good overall condition at the time of inspection. Several minor items of remedial work should be performed by the owner as soon as practicable. These include:

- 1) Restore the low areas on the dam to the original design elevation.
- 2) Fill the eroded areas behind the wing walls of the outlet structure.
- 3) Repair the rutting on the crest of the dam.
- 4) Repair concrete cracks with an appropriate filler where necessary.
- 5) Remove debris, when necessary, from the slotted flip bucket energy dissipator.
- 6) Periodically observe the three slides on the left slope of the spillway discharge channel and take appropriate remedial measures, if necessary.
- 7) Develop formal procedures for inspection, maintenance, and operation and keep formal records of these items

- 8) Periodically observe the minor crack on the left abutment.

In addition, the following operational measures are recommended to be undertaken by the owner:

- 1) Develop a detailed emergency operation and warning system.
- 2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

Submitted by:

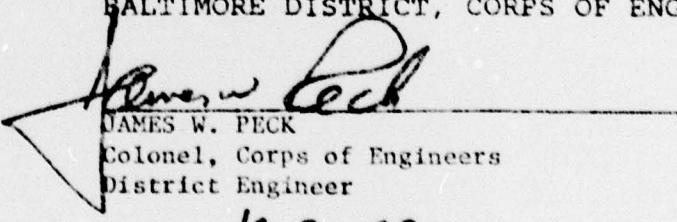
MICHAEL BAKER, JR., INC.

  
C. Y. Chen, Ph.D., P.E.  
Engineering Manager-Geotechnical

Date: 24 August 1979

Approved by:

DEPARTMENT OF THE ARMY  
BALTIMORE DISTRICT, CORPS OF ENGINEERS

  
JAMES W. PECK  
Colonel, Corps of Engineers  
District Engineer

Date: 12 Sep 79

GLADES DAM



Overall View

## TABLE OF CONTENTS

	<u>Page</u>
Section 1 - Project Information	1
Section 2 - Engineering Data	5
Section 3 - Visual Inspection	7
Section 4 - Operational Procedures	8
Section 5 - Hydraulic/Hydrologic	9
Section 6 - Structural Stability	11
Section 7 - Assessment, Recommendations/Remedial Measures	12

## PLATES

- Plate 1 - Location Plan
- Plate 2 - Watershed Map
- Plate 3 - Plan of Dam
- Plate 4 - Typical Embankment Section and Centerline Profile of Dam
- Plate 5 - Spillway Approach and Outlet Channel - Profile and Sections
- Plate 6 - Plan and Profile of Ogee Spillway
- Plate 7 - Elevation and Plan Views of Control Tower and Outlet Works
- Plate 8 - Inlet Control Tower

## APPENDICES

- Appendix A - Check List - Visual Inspection and Field Sketch
- Appendix B - Check List - Engineering Data
- Appendix C - Photographs
- Appendix D - Hydrologic and Hydraulic Computations
- Appendix E - Regional Geology

PHASE I INSPECTION REPORT  
NATIONAL DAM INSPECTION PROGRAM  
GLADES DAM  
NDI No. PA 00804, PennDER No. 10-72

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

- a. Authority - The Dam Inspection Act, Public Law 92-67, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.
- b. Purpose of Inspection - The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

- a. Description of Dam and Appurtenances - Glades Dam is a homogeneous earthfill dam with a maximum height of 24 feet and a crest length of 960 feet. The dam, owned and operated by the Pennsylvania Game Commission, is used primarily for waterfowl protection.

The spillway, consisting of a concrete ogee overflow with a slotted flip bucket energy dissipator, is located at the left abutment of the dam. The crest length is 100 feet. The discharge channel is lined with riprap for 130 feet downstream from the flip bucket.

The intake tower and 54 inch outlet conduit are located 400 feet from the left abutment of the dam. Two 3 foot by 5 foot sluice gates (El. 1197.0 feet and El. 1190.0 feet) are used to control the pool elevation. The 54 inch reinforced concrete pressure pipe outlet conduit has four cut-off collars on 26 foot centers along the upstream portion. A discharge basin is located at the downstream end of the outlet conduit.

- b. Location - Glades Dam is located in Cherry Township, Butler County, Pennsylvania, approximately 4 miles north of West Sunbury, Pennsylvania. Located approximately 1400 feet downstream from the dam is PA Route 308. The coordinates of the dam are N 41° 03.7' and W 79° 53.7'.

- c. Size Classification - The maximum height of the dam is 24 feet. The reservoir volume to the top of the dam at El. 1211.0 feet is 8600 acre-feet. Therefore, the dam is in the "Intermediate" size category.
- d. Hazard Classification - State Route 308 is located approximately 1400 feet downstream from the dam. Three homes are located approximately 3 miles downstream from the dam. These homes are generally at elevations such that loss of life resulting from a failure of the dam would not be likely. Therefore, the dam is classified in the "Significant" hazard category.
- e. Ownership - The dam and reservoir are owned by the Commonwealth of Pennsylvania, Pennsylvania Game Commission. Mr. Glenn L. Bowers is the current Executive Director of the Pennsylvania Game Commission. (Address: P.O. Box 1567, Harrisburg, PA 17120). Mr. Donald M. Schake is the Division Supervisor for the area.
- f. Purpose of Dam - The dam and reservoir are used for waterfowl development and protection.
- g. Design and Construction History - The dam was designed by Berger Associates, Inc. of Harrisburg, Pennsylvania. The Fowler Construction Company of Youngstown, Ohio constructed the dam from June 1973 to November 1974.
- h. Normal Operational Procedures - The pool elevation of Glades Dam is fluctuated throughout the year to provide for proper waterfowl management. The pool level is normally maintained at the crest of the spillway, El. 1200.0 feet, during the months from December through March. During April and May the pool is gradually lowered by means of the upper sluice gate on the intake tower to El. 1198.0 feet and is maintained at this level until September. From September to November the pool level is gradually allowed to rise to the level of the spillway crest.

### 1.3 PERTINENT DATA

a.	<u>Drainage Area (square miles)</u> -	22.0
b.	<u>Discharge at Dam Site (c.f.s.)</u> -	
	Maximum Flood (Autumn 1975) -	100
	Ungated Spillway Capacity (Top of Dam El. 1211.0 ft.) -	12,200
c.	<u>Elevation (feet above Mean Sea Level [M.S.L.])</u> -	
	Design Top of Dam -	1211.0
	Minimum Top of Dam -	1209.7
	Normal Pool -	1200.0
	Maximum Pool (Phase I Analysis <sup>1</sup> ) -	1207.6
	Spillway Crest -	1200.0
	Streambed at Centerline of Dam -	1187.0
	Maximum Tailwater -	Unknown
d.	<u>Reservoir (feet)</u> -	
	Length of Maximum Pool -	21,600
	Length of Normal Pool -	18,500
e.	<u>Storage (acre-feet)</u> -	
	Normal Pool (El. 1200.0 ft.) -	1350
	Top of Dam (El. 1211.0 ft.) -	8600
f.	<u>Reservoir Surface (acres)</u> -	
	Top of Dam (El. 1211.0 ft.) -	1480
	Normal Pool (El. 1200.0 ft.) -	390
g.	<u>Dam</u> -	
	Type -	Homogeneous earthfill
	Length (feet) -	960
	Height (feet) -	24
	Top Width (feet) -	20
	Side Slopes - Upstream -	3H:1V <sup>2</sup>
	Downstream -	3H:1V
	Zoning -	None
	Impervious Core -	None

<sup>1</sup>See Appendix D

<sup>2</sup>Horizontal to Vertical

**Cut-off** - An embankment cut-off key was installed just upstream of the centerline of the dam. The base width is 10 feet and the depth is 5 feet.

**Drains** - None

**h. Diversion and Regulating Tunnel** - None

**i. Spillway** -

**Type** - Concrete ogee overflow with slotted flip bucket energy dissipator

**Length of Crest (feet)** - 100

**Crest Elevation (feet M.S.L.)** - 1200.0

**Gates** - None

**Upstream Channel** - Earth-lined approach channel at El. 1196.0 feet.

**Downstream Channel** - Riprap-lined for 130 feet downstream from flip bucket. The elevation of the riprap is 1190.0 feet near the flip bucket and the remaining trapezoidal earth channel was designed with a one percent slope.

**j. Regulating Outlets** - The riser tower has two 3 foot by 5 foot sluice gate controls (El. 1197.0 feet and El. 1190.0 feet) for drawdown purposes. The outlet conduit is a 54 inch inner diameter reinforced concrete pressure pipe. Four concrete cut-off collars were installed on approximately 26 foot centers along the 116 foot long conduit. The flow then enters a discharge basin and the outlet channel.

## SECTION 2 - ENGINEERING DATA

### 2.1 DESIGN

The review of information for this dam included Pennsylvania Department of Environmental Resources' (PennDER) File No. 10-72. Included in the file were a microfiche copy of the correspondence and reports and a full size copy of the original design drawings. The microfiche contained the following information:

- 1) "First Interim Report for Glades Dam, Butler County, Pennsylvania," by Berger Associates, dated February 1969.
- 2) "Hydrological Study Pertaining to Glades Dam and Reservoir, Glades Waterfowl Project, Butler County, Pennsylvania," prepared by Berger Associates, dated May 1969.
- 3) Dam Permit Application Report prepared by PennDER, dated 11 May 1973.
- 4) Various construction progress reports, correspondence, and construction inspection reports by PennDER personnel.

"As built" drawings were forwarded by the Harrisburg office of the Pennsylvania Game Commission. Some of these have been included in this report as Plates 3 through 8.

### 2.2 CONSTRUCTION

During construction of the dam, a resident inspector was provided by PennDER, Bureau of Engineering and Construction, Division of Resident Supervision. In addition, occasional visits were performed by representatives of the Pittsburgh Region of PennDER. Modifications from the design drawings were incorporated into the "as built" drawings.

### 2.3 OPERATION

The operation of Glades Dam is the responsibility of the Pennsylvania Game Commission. No formal operation procedures or records are presently maintained. Historically, the reservoir is maintained at the normal pool level except during the waterfowl nesting season (June-August) when the reservoir is drawdown 24 inches.

#### 2.4 EVALUATION

- a. Availability - The information is readily available from PennDER's File No. 10-72, the files of the Pennsylvania Game Commission, and Berger Associates of Harrisburg, Pennsylvania.
- b. Adequacy - The information available is adequate for a Phase I Inspection of this dam.
- c. Validity - Observations and measurements performed during the visual inspection did not indicate any deviations from the information on the "as built" drawings.

## SECTION 3 - VISUAL INSPECTION

### 3.1 FINDINGS

- a. General - The dam and its appurtenant structures were found to be in very good overall condition at the time of the inspection. No unusual weather conditions were present on 11 May 1979 during the inspection. Noteworthy deficiencies are described below. The complete visual inspection check list and field sketch are given in Appendix A.
- b. Dam - The embankment had good vegetative cover on both the crest and the downstream slope; the riprap on the upstream slope was in good condition at the time of the inspection. No seepage or signs of instability were observed on the embankment. However, the level survey indicated several low areas on the crest (see Top of Dam Profile, Sheet 3 of 12, Appendix D).
- c. Appurtenant Structures - The overall condition of the appurtenant structures was good at the time of the inspection. However, minor debris was present in the slotted flip bucket energy dissipator. Cracks were observed in the right training wall of the spillway. The wing wall of the discharge basin was separated from the head wall of this structure and minor erosion was occurring behind the wing wall. Three slide areas (see Photos 11 and 12) have occurred in the slope adjacent to the discharge channel of the spillway.
- d. Reservoir Area - No problems were observed in the reservoir area.
- e. Downstream Channel - Two discharge channels were excavated during construction and come together approximately 500 feet downstream from the dam at the original streambed. Approximately 1400 feet downstream from the dam is the roadway embankment and culvert for PA Route 308. Located approximately 14,000 feet downstream from the dam are 3 homes in low-lying areas along the South Branch of Slippery Rock Creek.

## SECTION 4 - OPERATIONAL PROCEDURES

### 4.1 PROCEDURES

There are no formal emergency procedures in the event of impending catastrophic failure of the dam. The dam is visited frequently by personnel from the Pennsylvania Game Commission.

It is recommended that formal emergency procedures be prepared, prominently displayed, and furnished to all operating personnel.

### 4.2 MAINTENANCE OF DAM

Routine maintenance is performed periodically by the Pennsylvania Game Commission personnel on an as-needed basis.

### 4.3 MAINTENANCE OF OPERATING FACILITIES

The drawdown facilities are operated several times a year as a part of the normal operating procedures for maintaining the reservoir at different levels for waterfowl protection. Maintenance of the facilities is performed by the Pennsylvania Game Commission.

### 4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There are no warning procedures in the event of a dam failure. An emergency warning procedure should be developed.

### 4.5 EVALUATION OF OPERATIONAL ADEQUACY

The condition and maintenance of the dam is adequate; however, formal procedures for inspection, maintenance, and operation should be developed and recorded. Formal records of the maintenance and operation should be kept.

## SECTION 5 - HYDRAULIC/HYDROLOGIC

### 5.1 EVALUATION OF FEATURES

- a. Design Data - Hydrologic and hydraulic design calculations were obtained from the files of PennDER. The spillway was designed in accordance with the Pennsylvania "C" Curve and was therefore required to have a capacity of 580 c.f.s. per square mile of drainage basin or a total capacity of 13,050 c.f.s. One year and 100-year frequency storm hydrographs were also developed and routed through the reservoir to determine their effects on the reservoir stage and downstream channel. A hydrograph with a peak discharge equal to the "C" curve discharge (13,050 c.f.s.) was also developed and routed through the reservoir. The results of these three routings are as follows:

Storm Hydrograph	Peak Inflow (c.f.s.)	Peak Outflow (c.f.s.)	Maximum Reservoir Elevation (feet)
1-year	782	350	1201.2
100-year	5400	3000	1204.4
"C" Curve	13,050	8500	1208.5

These storm hydrographs were developed by using a unit hydrograph and appropriate rainfall amounts from Technical Paper 40 (U.S. Weather Bureau). The unit hydrograph was developed by comparison with stream gage records for eight streams with similar drainage basin characteristics.

Storage-discharge relationships for the reservoir and spillway were also obtained from the design information. The spillway discharge rating was independently evaluated to determine the effects of the tailwater elevation. The rating calculated by the designer was found to be in close agreement and was therefore used in the flood routing analysis.

- b. Experience Data - No major floods have occurred since the dam was completed in 1974. According to the owners of the dam, the reservoir rose to a level approximately six inches above the spillway crest in the Autumn of 1975. This corresponds to a discharge from the spillway of approximately 100 c.f.s.

- c. Visual Observations - The low areas on the crest of the dam could have a minor effect on the hydraulic capability of the reservoir. No other conditions were observed at the time of the inspection that would indicate the dam and appurtenant structures could not operate satisfactorily in the event of a flood.
- d. Overtopping Potential - Glades Dam is classified as a "Significant" hazard - "Intermediate" size dam requiring evaluation for a spillway design flood (SDF) in the range of the 1/2 Probable Maximum Flood (1/2 PMF) to the Probable Maximum Flood (PMF). Since the dam is on the low end of the intermediate size category, the 1/2 PMF was chosen as the SDF. The hydrologic capabilities of the dam, reservoir, and spillway were evaluated by routing the 1/2 PMF through the reservoir with the aid of the U.S. Army Corps of Engineers' Flood Hydrograph Package, HEC-1. The 1/2 PMF hydrograph developed as part of this analysis had a peak discharge of 14,975 c.f.s., using a total storm runoff of 12.5 inches. The results of this routing indicate that the dam is capable of passing the 1/2 PMF with a maximum reservoir level of 1207.6 feet or 2.1 feet below the minimum crest of the dam.
- e. Spillway Adequacy - The dam, as outlined in the above analysis, is capable of passing approximately 75 percent of the PMF without overtopping. The spillway is therefore considered adequate according to the recommended criteria.

## SECTION 6 - STRUCTURAL STABILITY

### 6.1 EVALUATION OF STRUCTURAL STABILITY

- a. Visual Observations - No structural inadequacies were noted during the visual inspection of the dam.
- b. Design and Construction Data - According to the information in PennDER's files, the slopes have satisfactory slope stability safety factors for the dam as constructed and the type of material available at the dam site for construction. Based upon this information and the visual observations of the dam, it is concluded that no further assessment of the structural stability is necessary.
- c. Operating Records - No formal operating records are maintained. There is nothing in the operation procedures which indicates cause for concern relative to the structural stability of the dam.
- d. Post-Construction Changes - No changes which would affect structural stability of the dam have been made since construction was completed.
- e. Seismic Stability - The dam is located in Seismic Zone 1 of the "Seismic Zone Map of the Contiguous United States," Figure 1, page D-30, "Recommended Guidelines for Safety Inspection of Dams." This is a zone of very low seismic activity. Experience indicates that dams in this zone will have adequate stability under seismic loading conditions provided static stability conditions are satisfied and conventional safety margins exist. Glades Dam has been shown to meet the conventional static stability requirements; therefore, further consideration of the seismic stability is not warranted.

## SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

### 7.1 DAM ASSESSMENT

- a. Safety - Glades Dam was found to be in very good overall condition at the time of inspection. Glades Dam is a "Significant" hazard-"Intermediate" size dam requiring a spillway capacity in the range of 1/2 PMF to PMF. The 1/2 PMF was chosen as the SDF because the dam is on the low side of the "Intermediate" size category. As presented in Section 5, the spillway and reservoir are adequate to pass the 1/2 PMF without overtopping the dam.
- b. Adequacy of Information - The information available and the observations made during the field inspection are considered sufficient for this Phase I Inspection Report.
- c. Urgency - The owner should initiate the action discussed in paragraph 7.2 as soon as practicable.
- d. Necessity for Additional Data/Evaluation - No further investigation is necessary.

### 7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The inspection revealed certain items of remedial work which should be performed by the owner. These include:

- 1) Restore the low areas on the dam to the original design elevation.
- 2) Fill the eroded areas behind the wing walls of the outlet structure.
- 3) Repair the rutting on the crest of the dam.
- 4) Repair concrete cracks with an appropriate filler where necessary.
- 5) Remove debris, when necessary, from the slotted flip bucket energy dissipator.
- 6) Periodically observe the three slides on the left slope of the spillway discharge channel and take appropriate remedial measures if necessary.
- 7) Develop formal procedures for inspection, maintenance, and operation and keep formal records for these items.

- 8) Periodically observe the minor crack on the left abutment.

In addition, the following operational measures are recommended to be undertaken by the owner:

- 1) Develop a detailed emergency operation and warning system.
- 2) During periods of unusually heavy rain, provide around-the-clock surveillance of the dam.
- 3) When warning of a storm of major proportions is given by the National Weather Service, the owner should activate the emergency operation and warning system.

24

PLATES

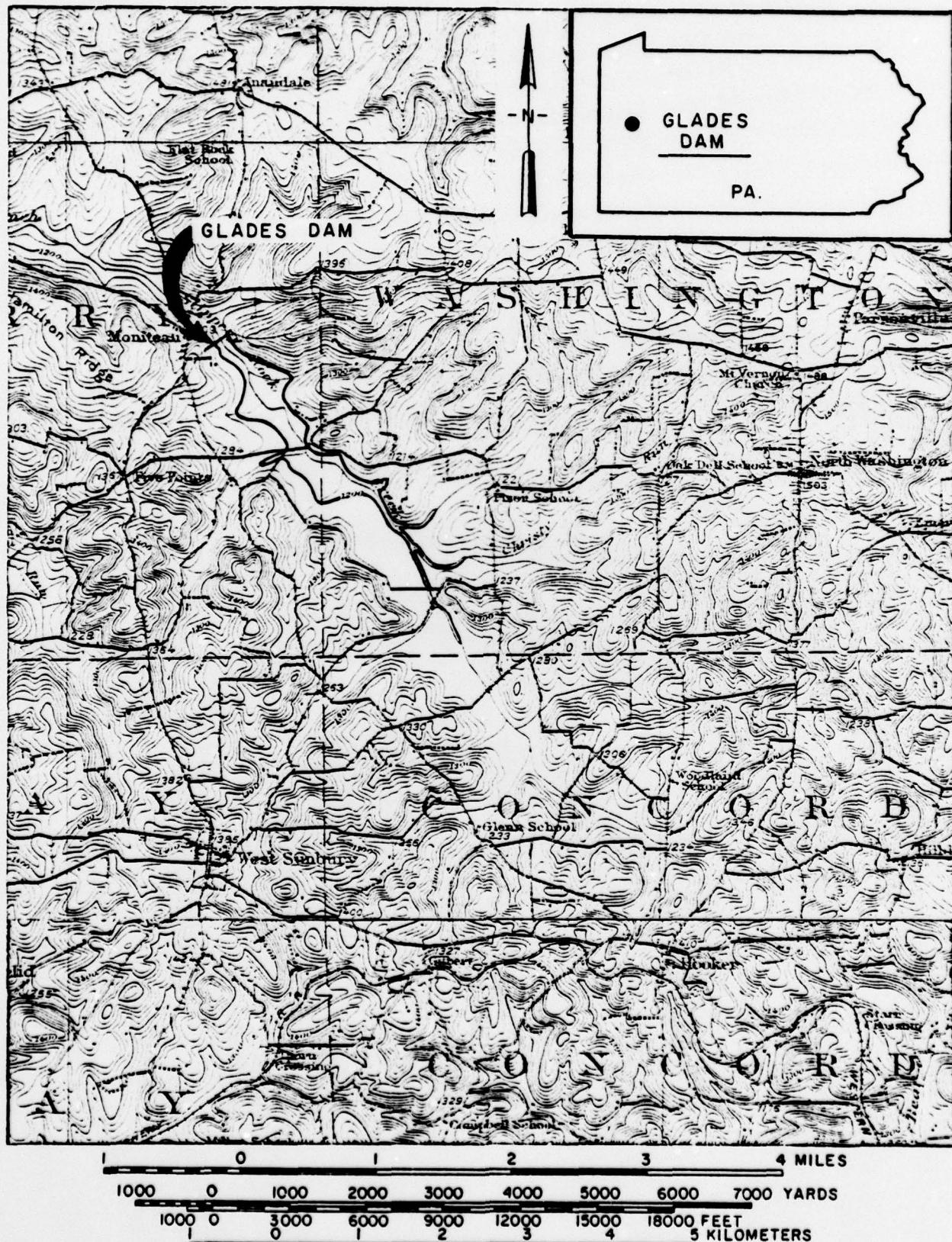


PLATE I LOCATION PLAN  
GLADES DAM

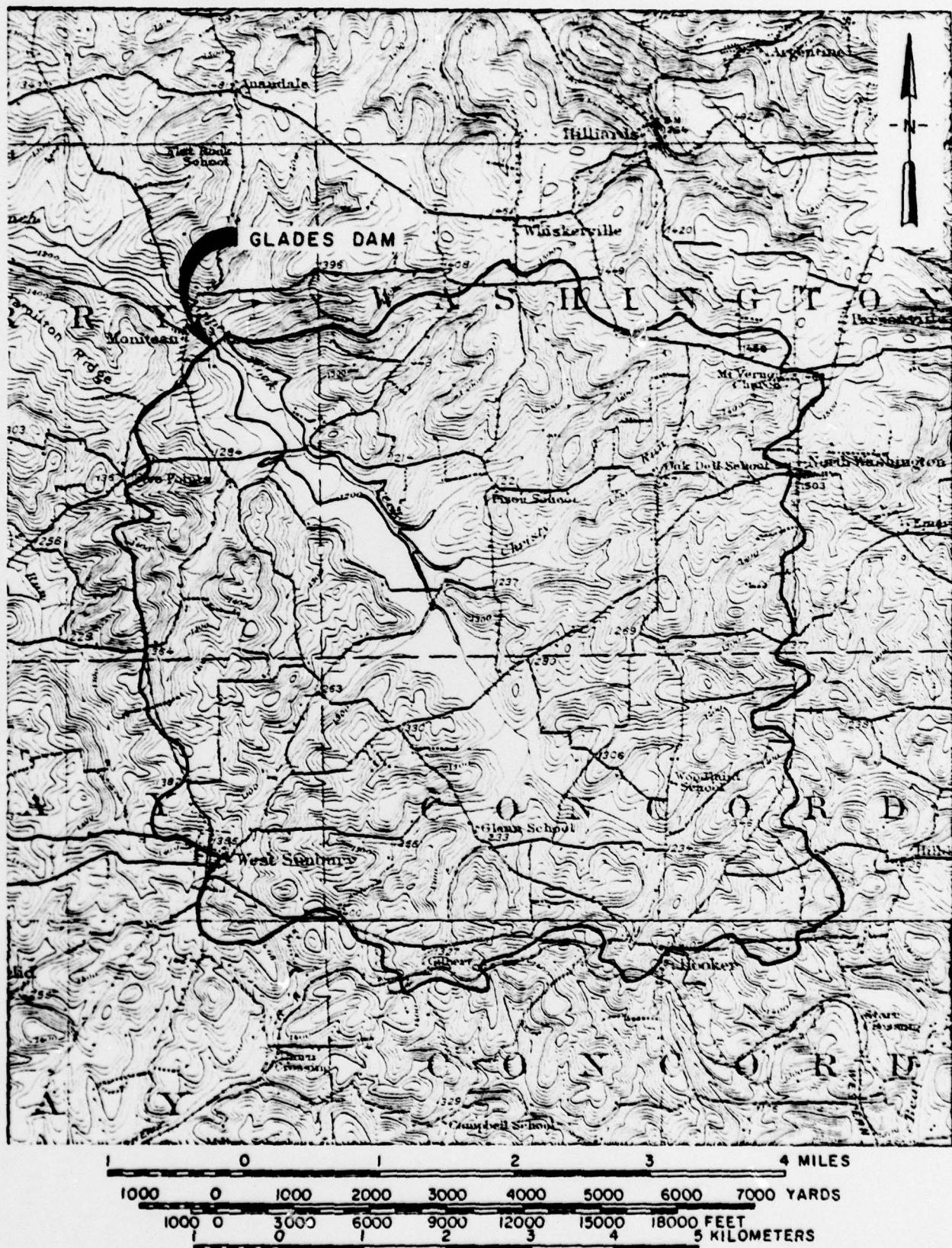


PLATE 2 WATERSHED MAP  
GLADES DAM

▲ FIELD DENSITY TEST RESULTS

DATE	STA	OFFSET	ELEV.	% COMPACTION	MOISTURE CONTENT	OPT. MOISTURE
9-17-73 1	2+75	0' RT	1189.6	100.2	15.1	13.5
9-17-73 2	1+95	8' RT	1190.1	94.4	16.5	13.5
9-17-73 3	2+15	40' RT	1191.0	101.7	13.4	13.5
9-17-73 4	1+90	14' RT	1191.0	99.3	13.7	13.5
9-18-73 5	4+10	9' RT	1189.0	98.5	12.0	16.6
9-18-73 6	6+00	8' RT	1191.5	93.8	15.9	16.6
9-18-73 7	5+00	37' LT	1190.2	103.1	15.5	16.6
9-18-73 8	3+50	40' RT	1191.7	92.0	16.8	16.6
9-18-73 9	6+00	7' RT	1188.2	90.1	15.8	16.6
9-19-73 10	6+00	10' RT	1191.7	107.6	13.5	16.6
9-19-73 11	3+50	45' RT	1191.3	94.0	13.5	16.6
9-24-73 12	5+40	21' RT	1194.2	107.0	16.4	16.6
9-24-73 13	4+00	6	1193.9	96.6	17.9	16.6
9-24-73 14	4+50	6	1193.6	93.9	13.3	16.6
9-24-73 15	6+00	17' LT	1201.3	93.0	14.6	16.6
10-4-73 6	7+50	10' RT	1203.2	99.4	10.5	16.6
10-4-73 17	9+00	6' RT	1204.4	95.6	14.4	16.6
10-4-73 18	7+00	6	1209.9	99.9	13.5	16.6
10-4-73 19	6+00	4' LT	1209.1	98.6	14.5	16.6
10-4-73 20	2+00	6	1185.3	99.8	13.2	13.5
10-6-73 21	2+25	16' LT	1201.8	98.7	14.5	13.5
10-6-73 22	1+95	6	1199.8	96.1	15.6	13.5
10-6-73 23	2+50	19' RT	1202.4	99.4	10.0	13.5
6-3-74 24	4+00	23' LT	1197.2	96.6	9.5	13.2
6-3-74 25	3+90	20' RT	1196.2	93.0	9.3	13.2
6-3-74 26	1+80	15' LT	1209.4	98.9	12.2	14.6
6-3-74 27	1+80	15' RT	1209.0	94.0	11.9	14.6
6-10-74 28	0+35	6	1202.0	97.7	10.6	15.9
6-10-74 29	0+30	6	1202.0	95.5	15.1	15.9
6-10-74 30	3+30	6	1202.0	95.5	9.9	15.9

- MTL Removed & Replaced
- MTL Removed & Replaced
- MTL Removed & Replaced
- MTL Removed & Replaced (Again)
- Additional Compaction Carried Out
- Additional Compaction Carried Out
- MTL Removed, Replaced & Compacted

DESCRIPTION	REFERENCE OF DRAWING PLATES
SECTION A-A	D-3
SECTION B-B	D-4
SECTION I-I	D-5
SECTION 2-2	D-5
SECTION 3-3	D-5
SECTION 4-4	D-5
SECTION 5-5	D-6
SECTION 6-6	D-6
SECTION 7-7	D-6
RIGHT SPILLWAY WALL	S-1
LEFT SPILLWAY WALL	S-2
OGEE SPILLWAY WALL	S-3
INLET CONTROL TOWER	S-4
FOOT BRIDGE & OUTLET CONTROL	S-5

10+00 D

9+00

8+00

7+00

6+00

5+00

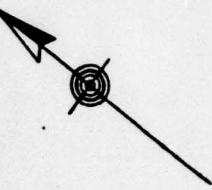
4+00

3+00

2+00

1+00

0+00 D



Limit of Work  
Sta. 1190

Limit of Clearing  
and Grubbing

OUTLET CHANNEL  
(CONTROL)

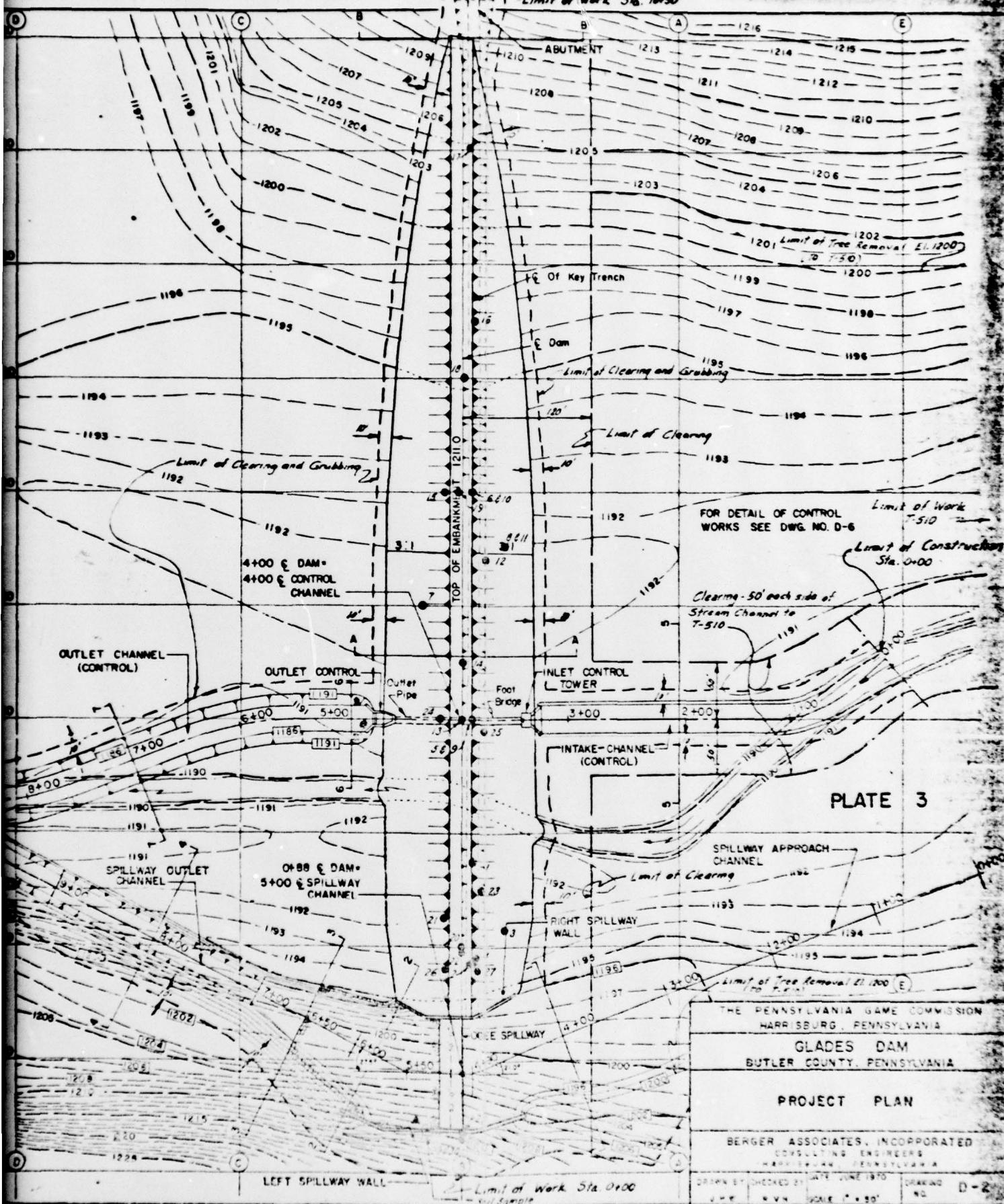
SPILLWAY  
CHANNEL

▲ NOTE: ▲ COMPACTED TEST  
NUMBER & LOCATION

Note: Tree removal includes all trees 4" in diameter or greater.

NOTE: ▲ Indicates As Built Information 11-8-74

THIS PAGE IS EAST QUALITY  
FROM COPY PUBLISHED 20 DEG

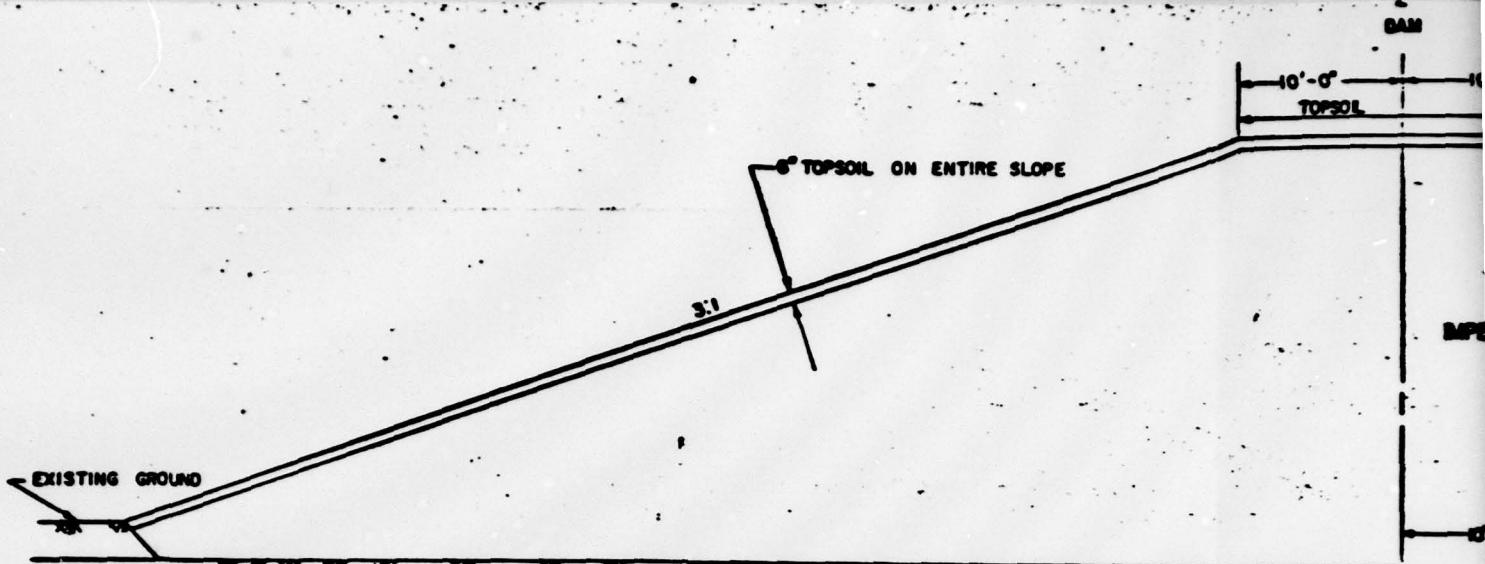


THE PENNSYLVANIA GAME COMMISSION  
HARRISBURG, PENNSYLVANIA

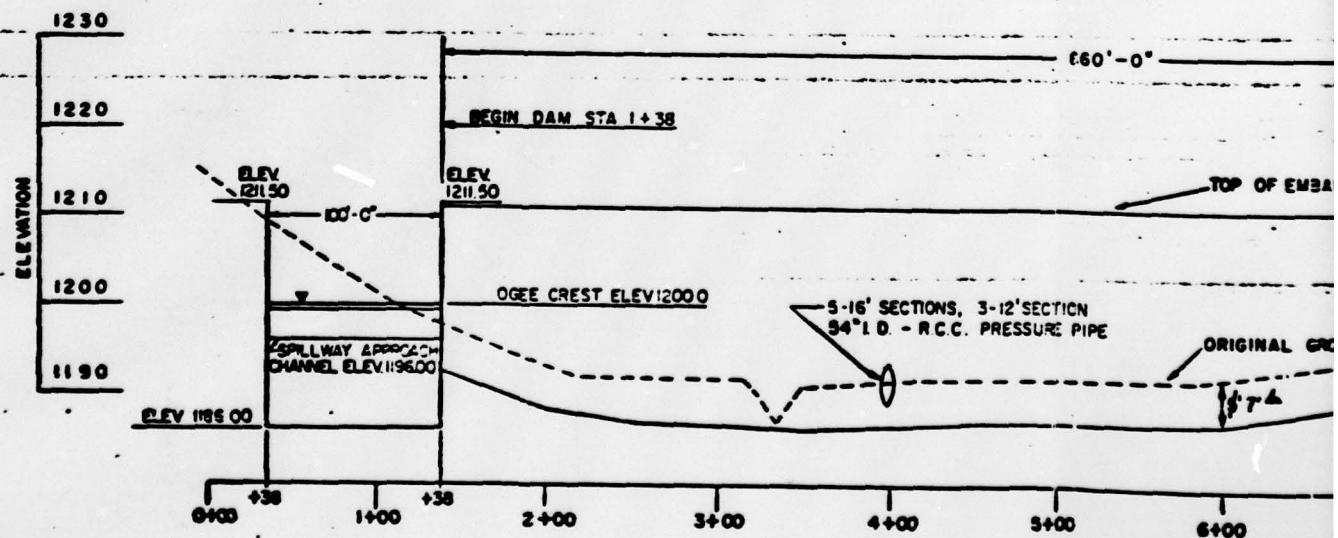
## PROJECT PLAN

BERGER ASSOCIATES, INCORPORATED  
CONSULTING ENGINEERS  
HARRISBURG, PENNSYLVANIA

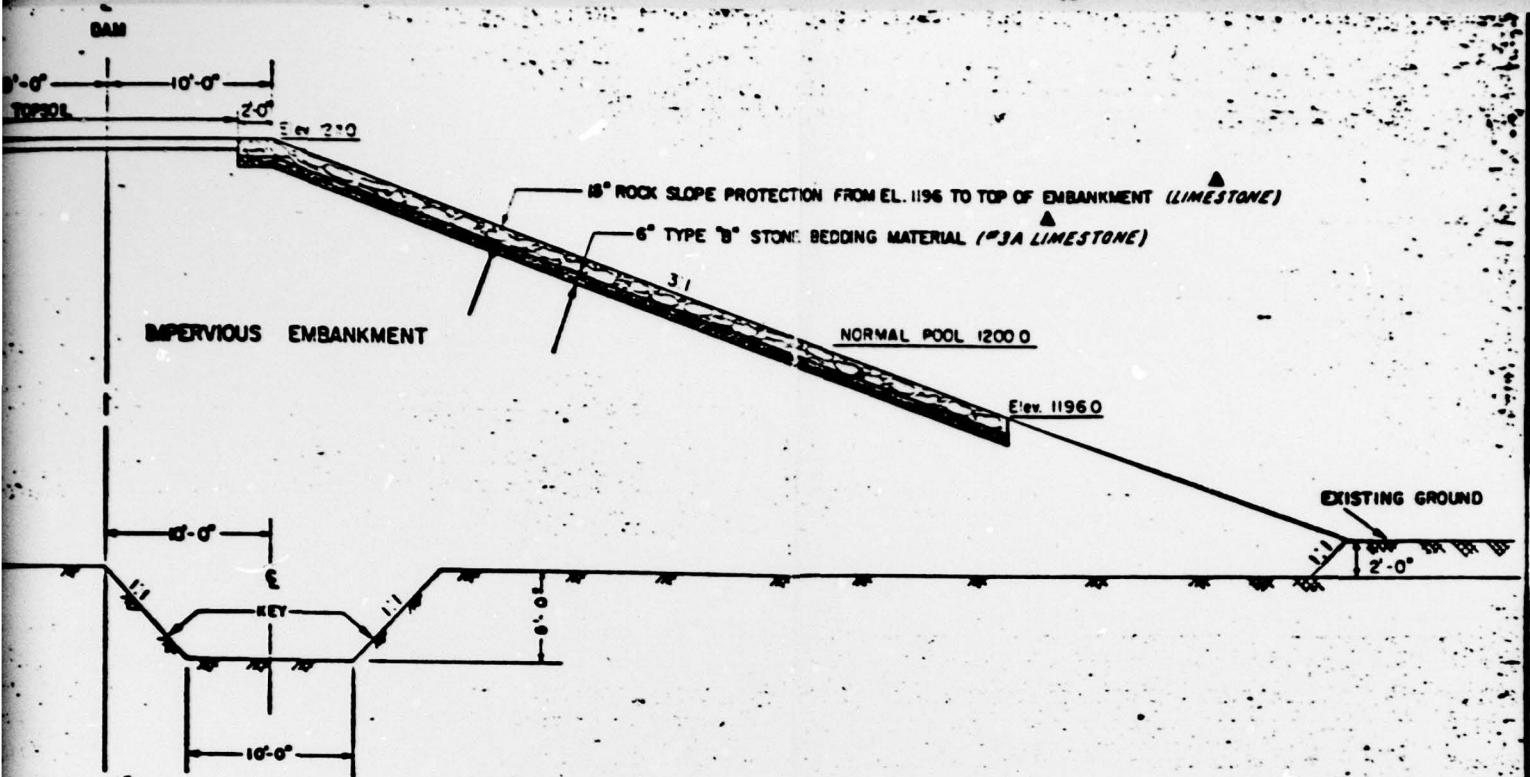
DRAWN BY	CHECKED BY	DATE JUNE 1970	DRAWING	D-2
JHE	RVN	SCHEMATIC	42	



TYPICAL EMBANKMENT  
A-A  
SCALE 1" = 5'-0"



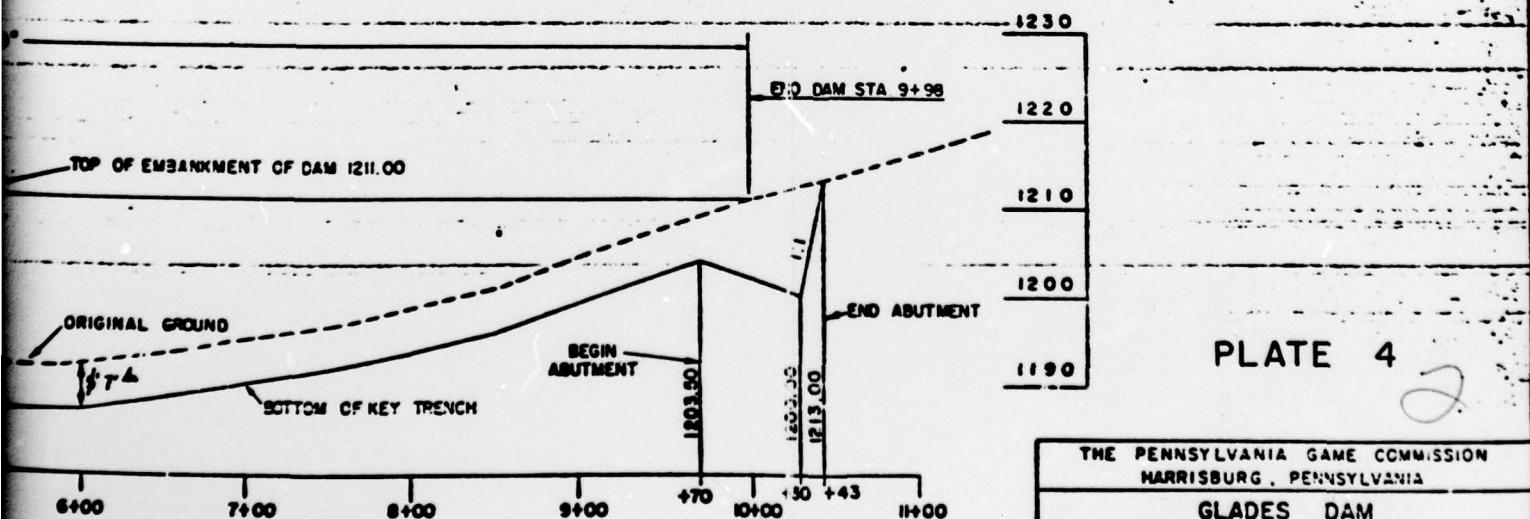
PROFILE C OF DAM  
SCALE: HOR. 1" = 50'-0"  
VEH. 1" = 10'-0"



### EMBANKMENT SECTION

A-A

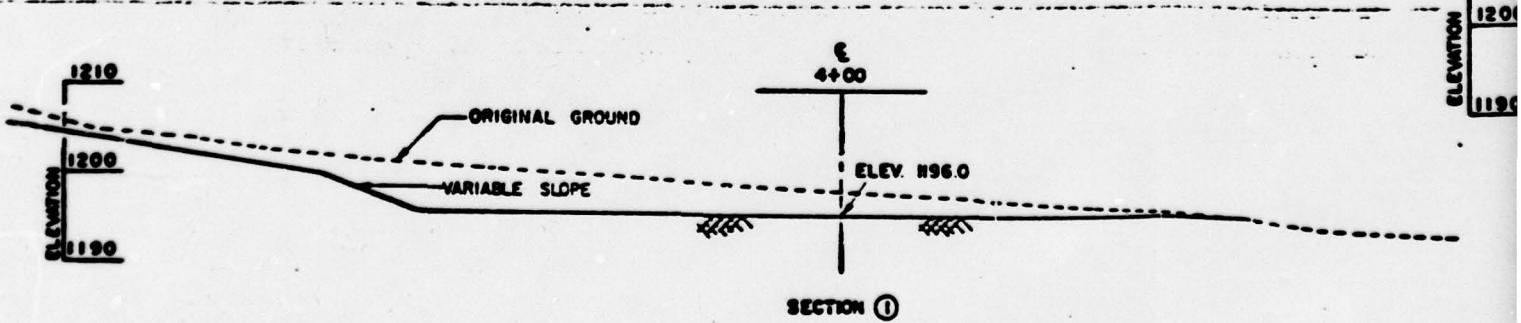
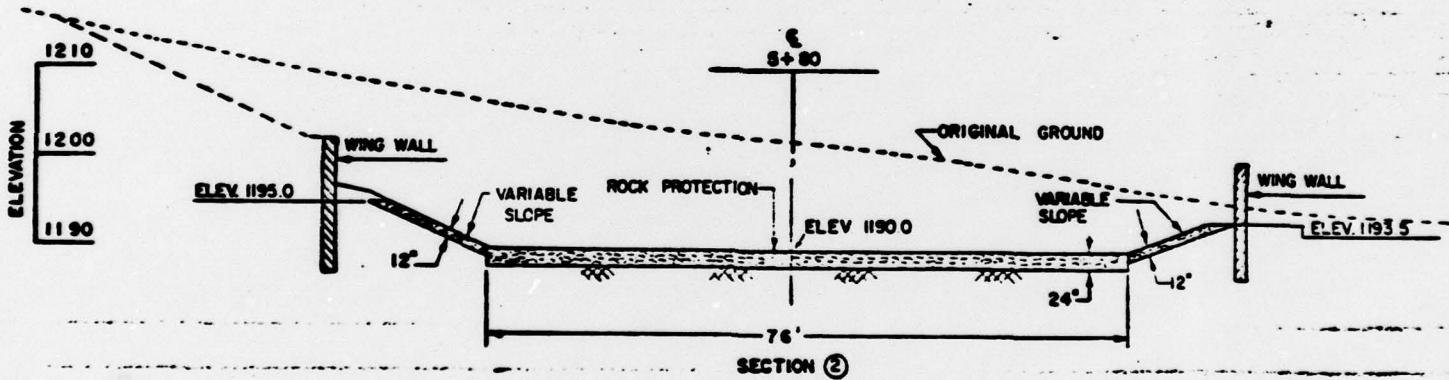
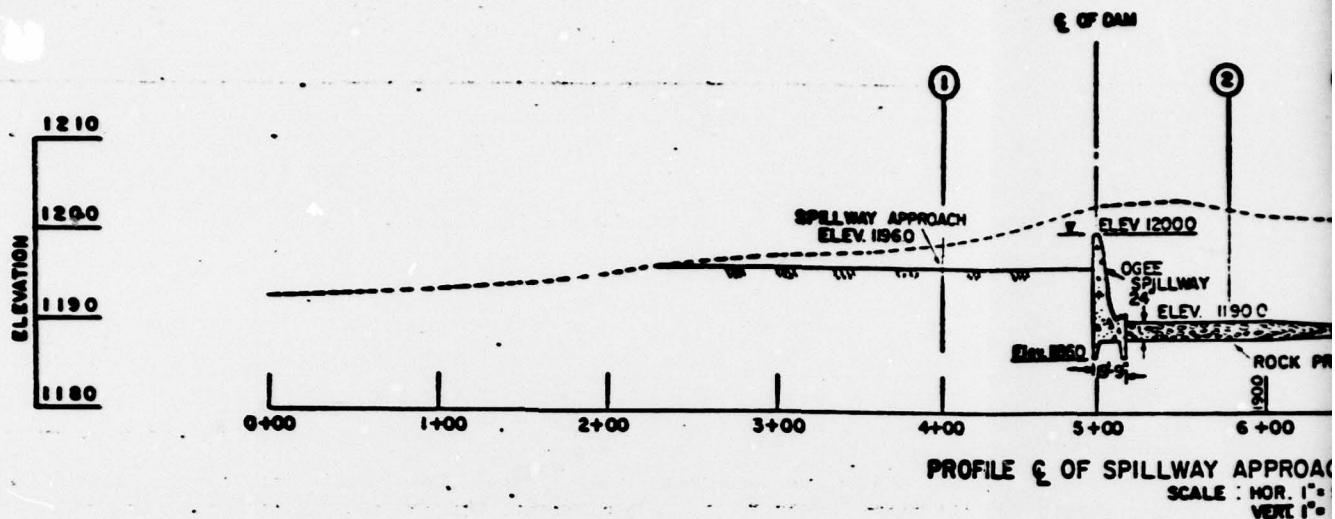
SCALE 1" = 5'-0"



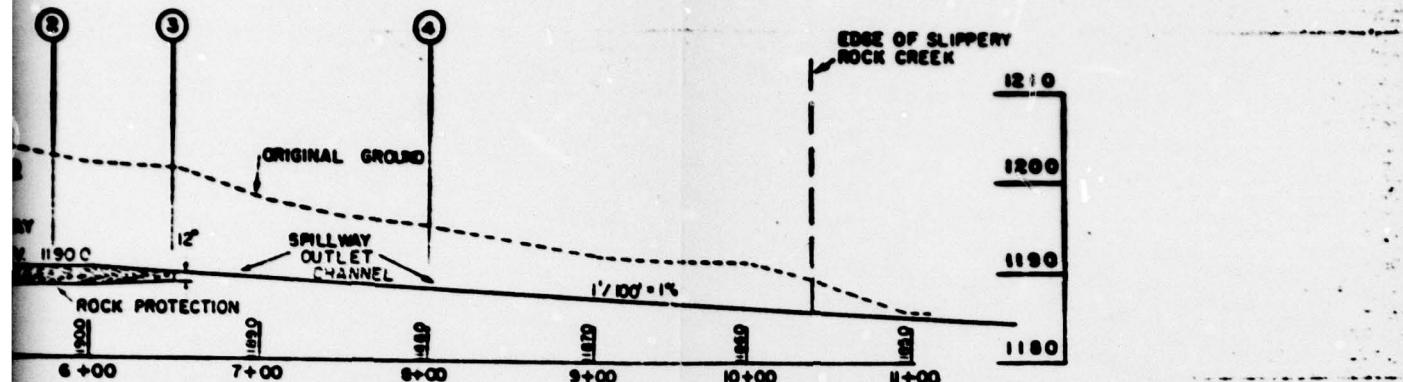
DAM

NOTE: ▲ indicates As Built Information 11-8-70

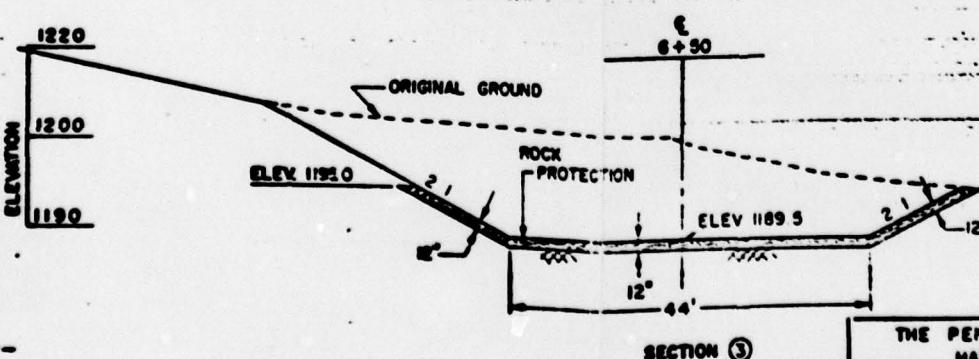
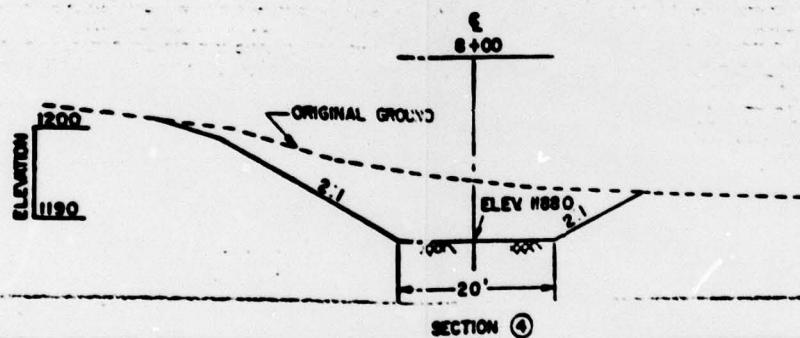
THE PENNSYLVANIA GAME COMMISSION HARRISBURG, PENNSYLVANIA	
GLADES DAM BUTLER COUNTY, PENNSYLVANIA	
TYPICAL EMBANKMENT SECTION PROFILE ♀ OF DAM	
BERGER ASSOCIATES, INCORPORATED CONSULTING ENGINEERS HARRISBURG, PENNSYLVANIA	
DRAWN BY D.J.W.	CHECKED BY R.V.H.
DATE JUNE 1970	
SCALE AS NOTED	
CROSSING NO. D-3	



SCALE 1'-0"



BY APPROACH & OUTLET CHANNEL  
ANGLE: NOR. 1° 30'  
VERE 1° 10'



**PLATE 5**

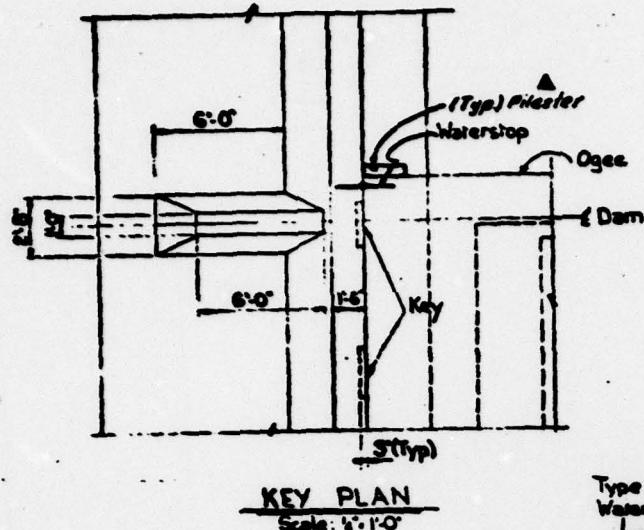
THE PENNSYLVANIA GAME COMMISSION  
HARRISBURG, PENNSYLVANIA

GLADES DAM  
BUTLER COUNTY, PENNSYLVANIA

SPILLWAY APPROACH & OUTLET CHANNEL  
PROFILE & SECTIONS

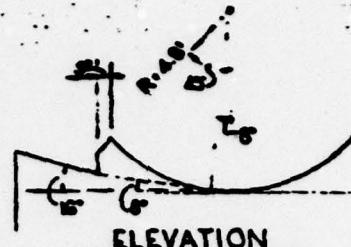
BERGER ASSOCIATES, INCORPORATED  
CONSULTING ENGINEERS  
HARRISBURG, PENNSYLVANIA

BRAUN BY CHECKED BY 247 JUN 1973 50000 D-5

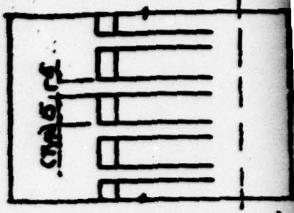


KEY PLAN

Scale: 1'-0"



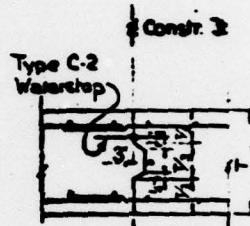
ELEVATION



PLAN

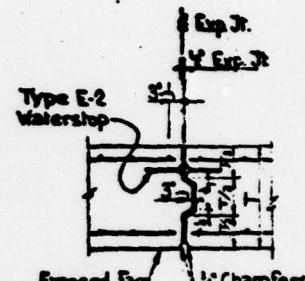
DETAIL OF BUCKET

No Scale



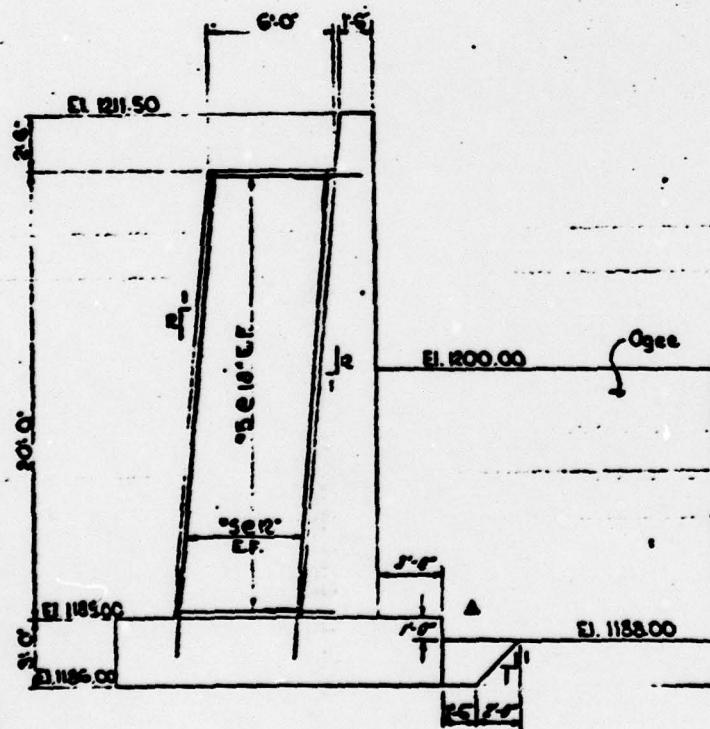
KEYED CONSTR JT

No Scale



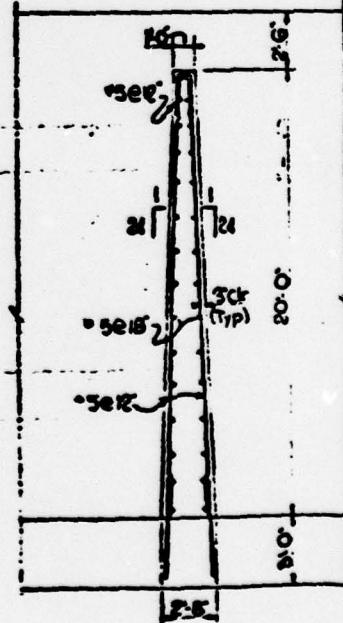
KEYED EXPANSION JT

No Scale



ELEVATION

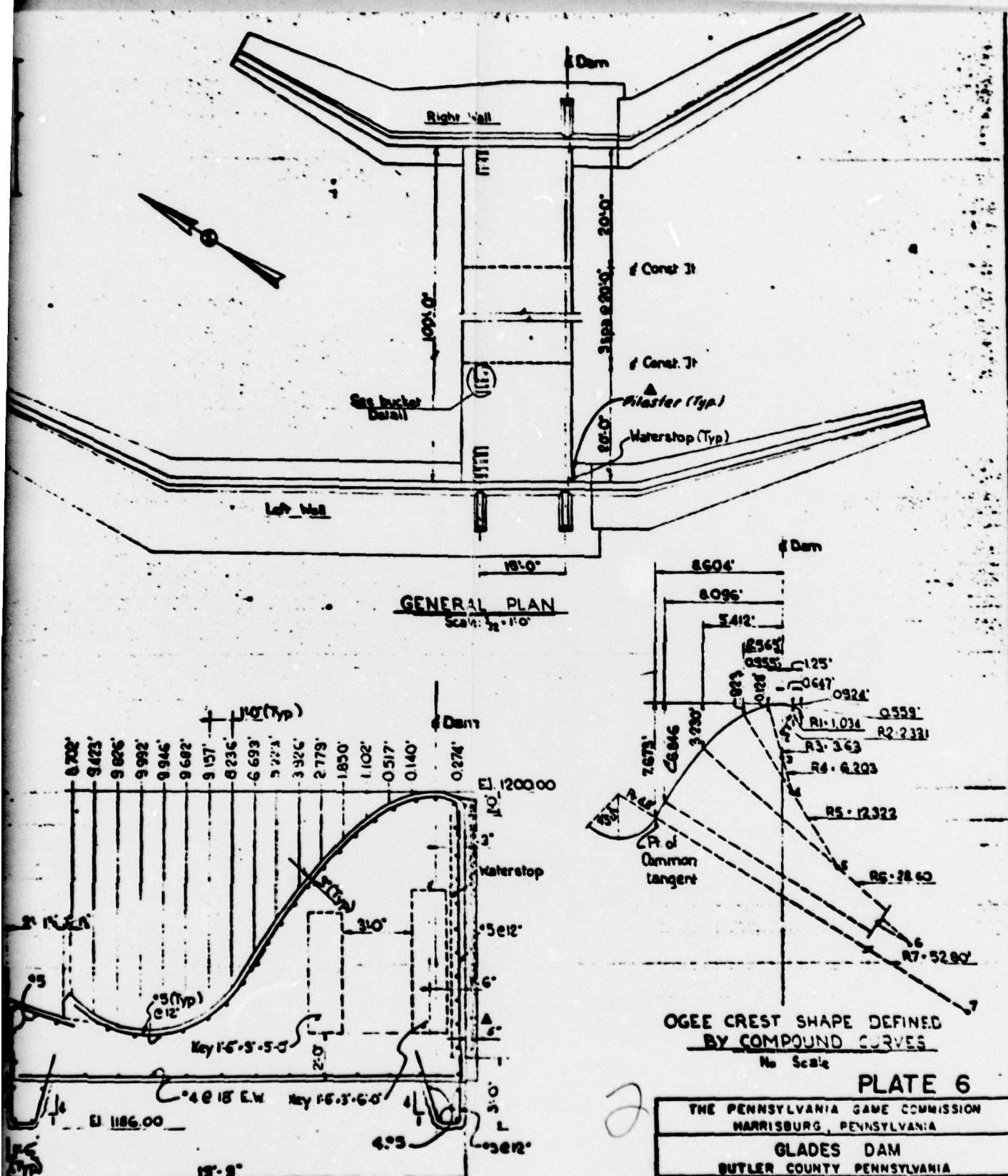
Scale: 1'-0"



END VIEW

Scale: 1'-0"

Notes:



SECTION C-SEE (Typ)

卷之三

EF Denses Each Face  
 RF. . Rear Face  
 EW. . Each Way

NOTE ▲ indicates As Built information 4-8-74

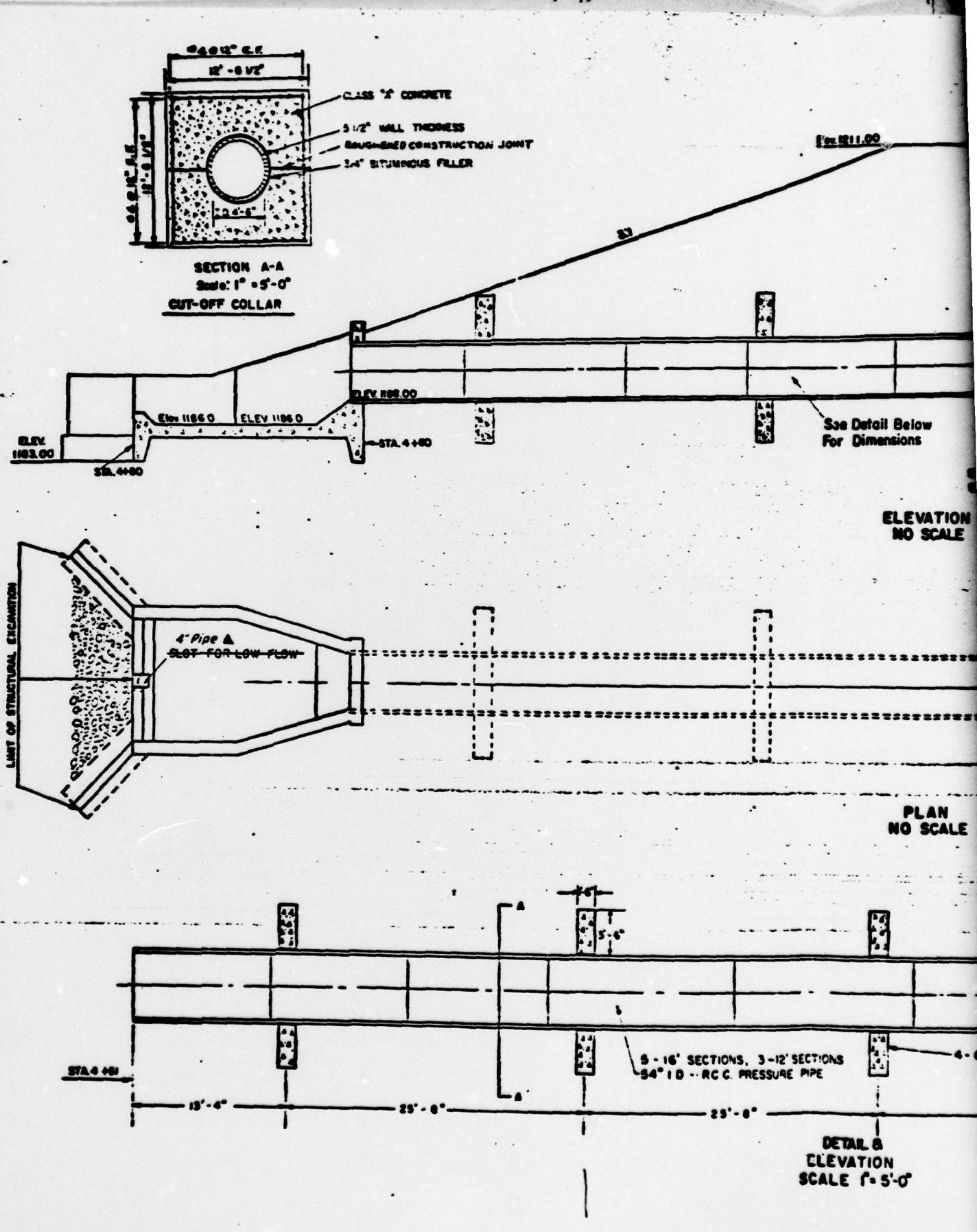
PLATE 6  
THE PENNSYLVANIA GAME COMMISSION

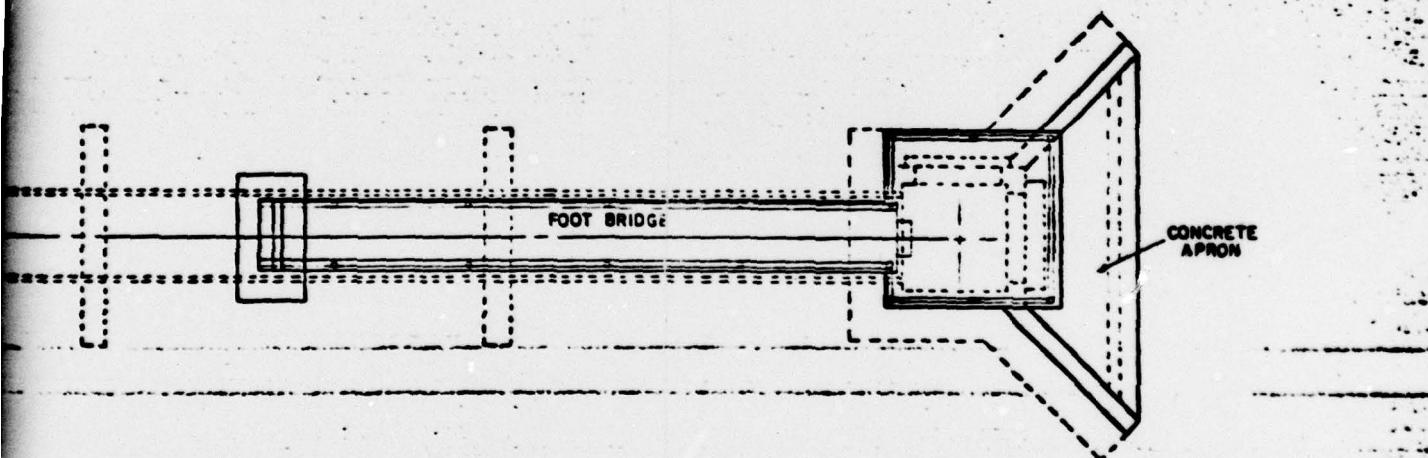
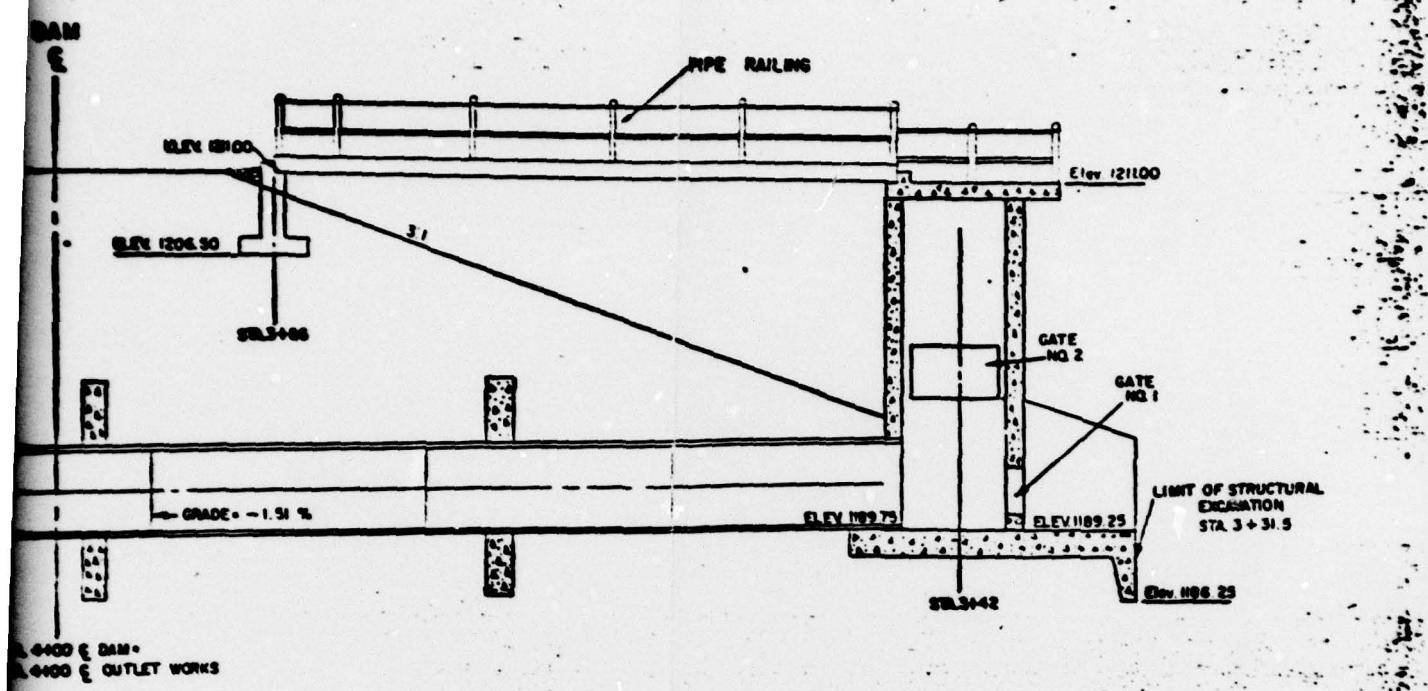
GLADES DAM  
BUTLER COUNTY PENNSYLVANIA

**OGEE SPILLWAY & WALL KEY**

BERGER ASSOCIATES, INCORPORATED  
CONSULTING ENGINEERS  
HARRISBURG, PENNSYLVANIA

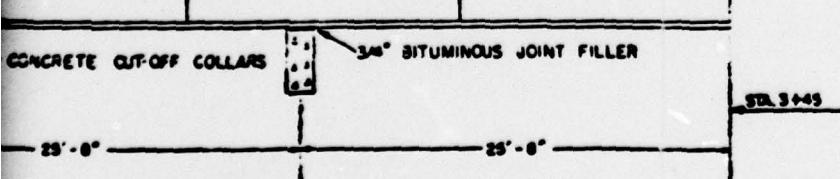
BROWN BY CHECKED BY DATE JUNE 70 CRAFTS  
JPS. 116 CO. S-3





REFER TO DRAWINGS S-4 & S-5 FOR STRUCTURAL DETAILS.

PLATE 7



THE PENNSYLVANIA GAME COMMISSION  
HARRISBURG, PENNSYLVANIA

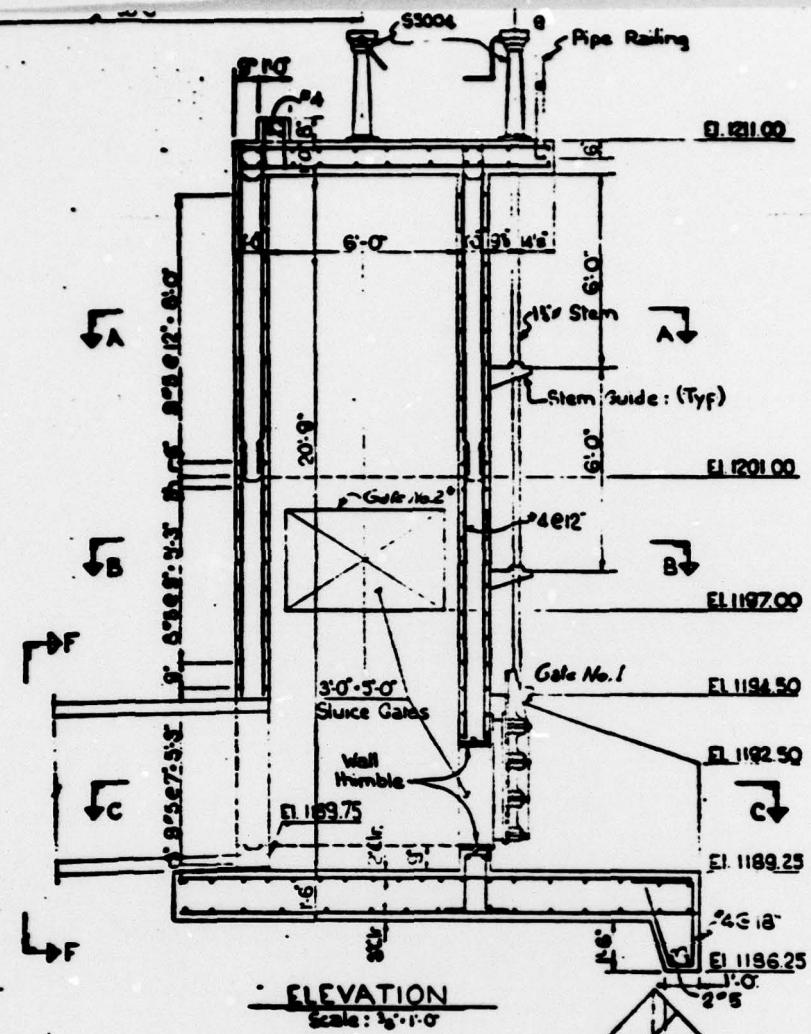
GLADES DAM  
BUTLER COUNTY, PENNSYLVANIA

ELEVATION & PLAN VIEWS  
CONTROL TOWER & OUTLET WORKS

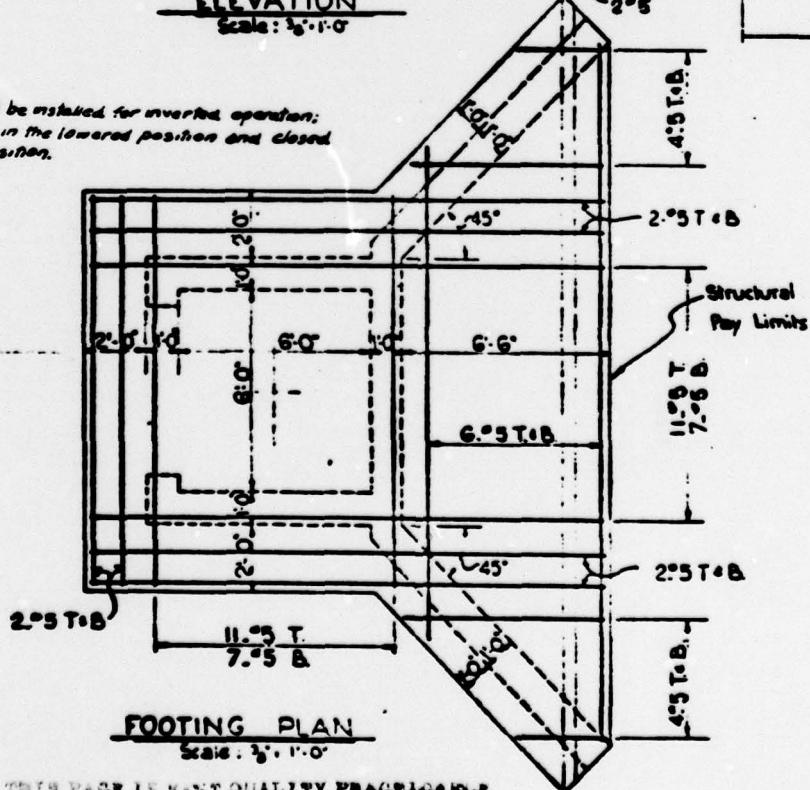
BERGER ASSOCIATES, INCORPORATED  
CONSULTING ENGINEERS  
HARRISBURG, PENNSYLVANIA

DRAWN BY: CHECKED BY: DATE: APRIL 1972 DRAWING NO. 0-7  
R.J.B. R.V.H. 1189.25 0-7

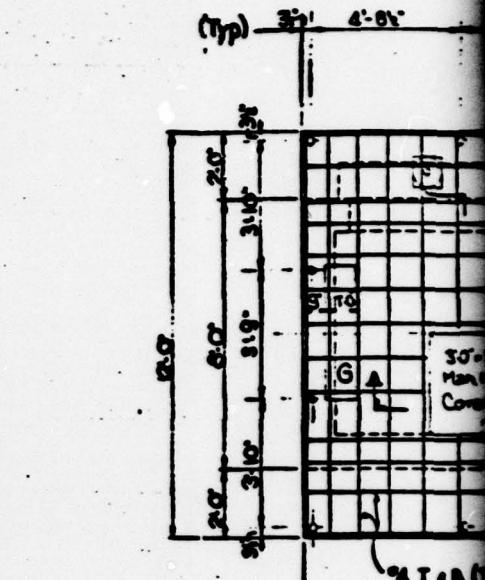
NOTE: & indicates As Built information 11-8-74



**Note:** Gate No. 2 shall be installed for inverted operation; that is, opened in the lowered position and closed in the raised position.



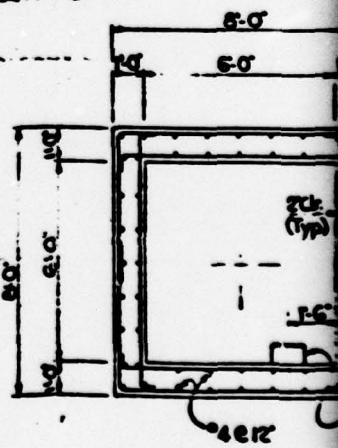
THIS PAGE IS EAST QUALITY PRODUCTION  
FROM COPY PUBLISHED IN DDM



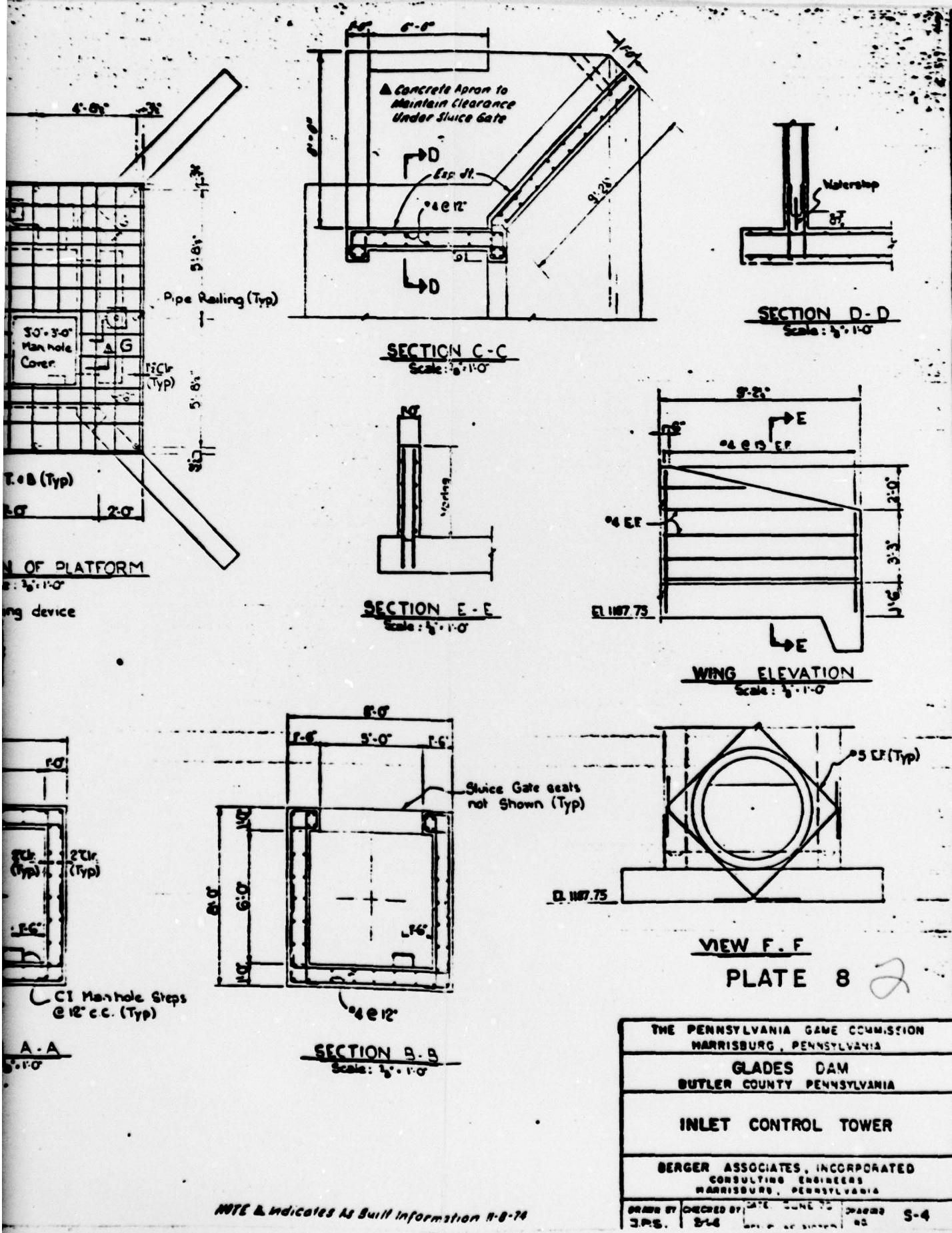
### Man hole cover

PLAN OF  
Scale 1:1000

SECTION G-G



SECTION A -  
Scale: 3°. 1' 0"



APPENDIX A

CHECK LIST - VISUAL INSPECTION  
AND FIELD SKETCH

Check List  
Visual Inspection  
Phase 1

Name of Dam	Glades Dam	County	Butler	State	PA	Coordinates	Lat. N 41° 03.7'
NDI #	PA 00804						
PENNDEP #	10-72						Long. W 79° 53.7'
Date of Inspection	11 May 1979	Weather	Sunny, calm	Temperature	85°F.		

Pool Elevation at Time of Inspection 1198.0 ft. \*M.S.L. Tailwater at Time of Inspection 1189.6 ft. \*M.S.L.

\*All elevations are referenced to the crest of the spillway (El. 1200.0 ft.)

Inspection Personnel:

Michael Baker, Jr., Inc.

Owner's Representatives:

Rodney E. Holderbaum  
James G. Ulinski

Site Visit - 19 July 1979

Dr. C. Y. Chen  
James G. Ulinski

James G. Ulinski

Recorder

A-2

CONCRETE/MASONRY DAMS - Not Applicable

Name of Dam: GLADES DAM  
MDI # PA 00804

VISUAL EXAMINATION OF STRUCTURE TO  
ABUTMENT/EMBANKMENT  
JUNCTIONS

LEAKAGE

STRUCTURE TO  
ABUTMENT/EMBANKMENT  
JUNCTIONS

DRAINS

WATER PASSAGES

FOUNDATION

OBSERVATIONS	REMARKS OR RECOMMENDATIONS

Name of Dam: GLADES DAMNDI # PA 00804

CONCRETE/MASONRY DAMS - Not Applicable

VISUAL EXAMINATION OF OBSERVATIONS REMARKS OR RECOMMENDATIONSSURFACE CRACKS  
CONCRETE SURFACES

STRUCTURAL CRACKING

VERTICAL AND HORIZONTAL  
ALIGNMENT

MONOLITH JOINTS

CONSTRUCTION JOINTS

Name of Dam:	GLADES DAM	EMBANKMENT
NDI #	PA 00804	
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	A surface crack was observed in the abutment immediately to the left of the spillway training wall. The crack is 2 ft. long longitudinally to the dam axis, 1 ft. deep, and 0.5 in. wide.	The crack is not a problem at the present time but should be examined and recorded in future inspections.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None observed	
SLoughing or Erosion of Embankment and Abutment Slopes	The embankment adjacent to the right spillway training wall is rutted and low in a few minor areas. Maintenance vehicles have caused rutting and removal of the cover vegetation at the access to the dam crest on the right abutment of the dam.	Both areas should be regraded, restored to the original crest elevation, and reseeded with an appropriate mixture.
Vertical and Horizontal Alignment of the Crest	Visual inspection of the horizontal alignment indicated no problems. The level survey of the top of the dam showed several low areas on the dam. (See Top of Dam Profile, Sheet 3 of 12, Appendix D.)	The low areas should be restored to the original crest E1. 1211.0 ft. and reseeded with an appropriate mixture.
RIPRAP FAILURES	None	

Name of Dam: GLADES DAM  
NDI # PA 00804

VISUAL EXAMINATION OF		OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM		No other problems other than the rutting, low areas, and vertical crack previously presented on page A-4.	
ANY NOTICEABLE SEEPAGE		None	
STAFF GAGE AND RECORDER		None installed	
DRAINS		None	

## OUTLET WORKS

Name of Dam: GLADES DAM  
NOL # PA 00804

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Since the conduit was flowing approximately half full at the time of inspection, no assessment of its condition could be made.	
INTAKE STRUCTURE	Very good condition. No deterioration of the concrete was observed. The gates and gate controls are also in good condition.	The gate controls should be lubricated periodically.
OUTLET STRUCTURE	Some separation at the construction joints (approximately 0.5 in.) was observed between the main head wall and the wing walls of the outlet structure.	The separation is considered minor and should be repaired during routine maintenance.
OUTLET CHANNEL	Some minor erosion has occurred at the end of the stilling basin adjacent to the wing walls and approximately 50 ft. downstream from the end of the stilling basin.	
EMERGENCY GATE	A 54 in. dia. gated outlet can be used for emergency drawdown of the lake.	The gates are operated annually to assure proper operation.

UNGATED SPILLWAY			
Name of Dam:	GLADES DAM	VISUAL EXAMINATION OF	OBSERVATIONS
NOI # PA 00804		CONCRETE WEIR	Very good condition. No deterioration of the concrete surfaces in the form of spalling or cracking was observed.
		APPROACH CHANNEL	No problems observed
		DISCHARGE CHANNEL	Three small slides have occurred on the left bank of the outlet channel approximately 300 ft. downstream from the spillway crest. According to PA Game Commission personnel, these slides occurred during construction.
		BRIDGE AND PIERS	Not Applicable
		SPILLWAY TRAINING WALLS	Minor cracking was observed on the inside of the right training wall downstream from the concrete weir. Minor flow was exiting from the first two weep holes on the left side. The middle weep hole on the right side appeared clogged.
			The cracks should be repaired with an appropriate filler.

Name of Dam: GLADES DAMNDI # PA 00804

GATED SPILLWAY - Not Applicable

VISUAL EXAMINATION OF CONCRETE SILL      OBSERVATIONS

REMARKS OR RECOMMENDATIONS

APPROACH CHANNEL

DISCHARGE CHANNEL

BRIDGE AND PIERS

GATES AND OPERATION  
EQUIPMENT

Name of Dam: GLADES DAMNDI # PA 00804

INSTRUMENTATION - Not Applicable	
VISUAL EXAMINATION	OBSERVATIONS
MONUMENTATION/SURVEYS	REMARKS OR RECOMMENDATIONS
	OBSERVATION WELLS
	WEIRS
	PIEZOMETERS
	OTHER

Name of Dam:	GLADES DAM	RESERVOIR
MDI #	00804	VISUAL EXAMINATION OF
SLOPES		OBSERVATIONS
		The reservoir slopes are mildly sloping and well vegetated.
SEDIMENTATION		REMARKS OR RECOMMENDATIONS
		Judging from the age of the reservoir and the watershed cover, sedimentation should not be a significant problem.

## DOWNSTREAM CHANNEL

Name of Dam: GLADES DAM  
NDI # PA 00804

VISUAL EXAMINATION OF DOWNSTREAM CHANNEL

CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
	A road bridge is located several hundred ft. downstream from the dam. Although numerous trees and brush are located in the downstream channel and over the banks areas, no serious obstructions to discharges from the dam were observed.	The bridge should not affect discharges from the dam even during large storms.
SLOPES	The slopes adjacent to the downstream channel are moderately sloped and primarily well vegetated. The slope of the downstream channel is mild, dropping approximately 5 ft. per mi.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 1400 ft. downstream from the dam is PA Route 308. Approximately 14,000 ft. downstream from the dam are 3 homes in low-lying areas along the south branch of Slippery Rock Creek.	



**APPENDIX B**

**CHECK LIST - ENGINEERING DATA**

CHECK LIST	
ENGINEERING DATA	
DESIGN, CONSTRUCTION, OPERATION	
ITEM	REMARKS
PLAN OF DAM	See Plate 3 of this report.
REGIONAL VICINITY MAP	See Plate 1 of this report, a portion of a U.S.G.S. 15 minute topographic quadrangle for this area.
CONSTRUCTION HISTORY	The dam was designed by Berger Assoc. of Camp Hill, Pennsylvania and constructed by the Fowker Construction Co. of Youngstown, Ohio. The construction period was from June 1973 to November 1974. Resident inspection during construction was provided by PennDER.
TYPICAL SECTIONS OF DAM	See Plates 4, 5, 6, 7, and 8 of this report.

**HYDROLOGIC/HYDRAULIC DATA** The design calculations are contained in the files of PennDER and are summarized in Section 5 of this report.

**OUTLETS - PLAN and DETAILS** See Plates 7 and 8 of this report.

- CONSTRAINTS Two sluice gated outlets are incorporated into the intake tower. Details are included in the Design Plans.
- DISCHARGE RATINGS are contained in the Hydrology Design Report and are summarized in Appendix D of this report.

**RAINFALL/RESERVOIR RECORDS** Rainfall and stream gage records for streams in western PA, with drainage basin characteristics similar to Glades Dam drainage basin, are contained in the PennDER files.

Name of Dam: GLADES DAM  
NDI # PA 00804

B-2

<u>ITEM</u>		<u>REMARKS</u>
DESIGN REPORTS	1) 2)	"First Interim Report for Glades Dam" by Berger Assoc., February 1969. "Hydrological Study Pertaining to Glades Dam and Reservoir" by Berger Assoc., May 1969. Both of these reports are available in the PennDER file.

GEOLOGY REPORTS See Appendix E of this report.

DESIGN COMPUTATIONS  
HYDROLOGY & HYDRAULICS  
DAM STABILITY  
SEEPAGE STUDIES  
The summary results of the hydrology and hydraulics computations are contained in the "Hydrological Study Pertaining to Glades Dam and Reservoir," available in the PennDER file. The summary results of the dam stability analyses are contained in the "First Interim Report for Glades Dam," available in the PennDER file.

MATERIALS INVESTIGATIONS  
BORING RECORDS  
LABORATORY  
FIELD  
The boring records and material investigations are presented on Sheets B-1 through B-7 of the design drawings. The summary results of the laboratory and field testing programs are presented in the "First Interim Report for Glades Dam" by Berger Assoc., February 1969. All of this information is available in PennDER's file.

POST-CONSTRUCTION SURVEYS OF DAM No information available

BORROW SOURCES The borrow sources for the dam were from the excavation of the spillway and spillway outlet channel and from an area in the right portion of the reservoir approximately 400 to 1200 ft. upstream from the centerline of the dam. Soil classification tests performed on the borrow material indicated that the area consisted primarily of CL, ML, and CL-ML soils.

Name of Dam:	GLADES DAM
NDI #	PA 00804
ITEM	REMARKS

MONITORING SYSTEMS None

MODIFICATIONS None

HIGH POOL RECORDS None

POST-CONSTRUCTION ENGINEERING  
STUDIES AND REPORTS None

PRIOR ACCIDENTS OR FAILURE OF DAM None  
DESCRIPTION REPORTS

MAINTENANCE No formal records are maintained.  
OPERATION RECORDS

Name of Dam:	GLADES DAM
NDI #	PA 00804
ITEM	REMARKS

SPILLWAY PLAN.

SECTIONS,  
and  
DETAILS

See Plates 5 and 6 of this report. Additional structural details of the spillway are shown on design drawings S-1 and S-2.

OPERATING EQUIPMENT  
PLANS & DETAILS

See Plate 8 of this report.

CHECK LIST  
HYDROLOGIC AND HYDRAULIC DATA  
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 22.0 sq.mi. (primarily farmland and forests)

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 1200.0 ft. (1350 ac.-ft.)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 1209.7 ft. (7320 ac.-ft.)

ELEVATION MAXIMUM DESIGN POOL: 1208.0 ft.

ELEVATION TOP DAM: 1211.0 ft.

CREST: Spillway

- a. Elevation 1200.0 ft.
- b. Type Concrete ogee with flip bucket energy dissipator
- c. Width 100 ft.
- d. Length Approximately 500 ft. including discharge channel
- e. Location Spillover At left abutment of dam
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type Concrete intake riser and 54 in. concrete contuit
- b. Location Approximately 600 ft. from right abutment
- c. Entrance inverts El. 1197.0 ft. and El. 1190.0 ft.
- d. Exit inverts El. 1188.0 ft.
- e. Emergency draindown facilities 3 ft. x 5 ft. sluice gate

HYDROMETEOROLOGICAL GAGES: None installed

- a. Type
- b. Location
- c. Records

MAXIMUM NON-DAMAGING DISCHARGE Unknown

**APPENDIX C**

**PHOTOGRAPHS**

## DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam from Right Abutment

Photo 1 - View of Spillway and Reservoir from Left Abutment Hillside

Photo 2 - Close-up View of Spillway and Slotted Flip Bucket Energy Dissipator

Photo 3 - View Looking Downstream at Discharge Channel from Spillway

Photo 4 - View of Intake Control Tower

Photo 5 - Close-up View of Three Foot by Five Foot Intake at El. 1197.0 feet (The sluice gate was designed to be in the inverted position.)

Photo 6 - View of Downstream Embankment, Outlet Structure, and Discharge Channel for the Outlet Conduit

Photo 7 - Close-up View of Outlet Structure (Note: Backwash and erosion around wing walls.)

Photo 8 - View Looking Downstream at Discharge Channel for the Outlet Conduit

Photo 9 - View of Downstream Area

Photo 10 - View of Drainage Ditch on the Left Abutment of the Dam

Photo 11 - View of One of Three Small Slides on the Left Side Slope of the Spillway Discharge Channel

Photo 12 - View of Another Small Slide on the Left Side Slope of the Spillway Discharge Channel

Note: Photographs were taken on 11 May 1979.

GLADES DAM

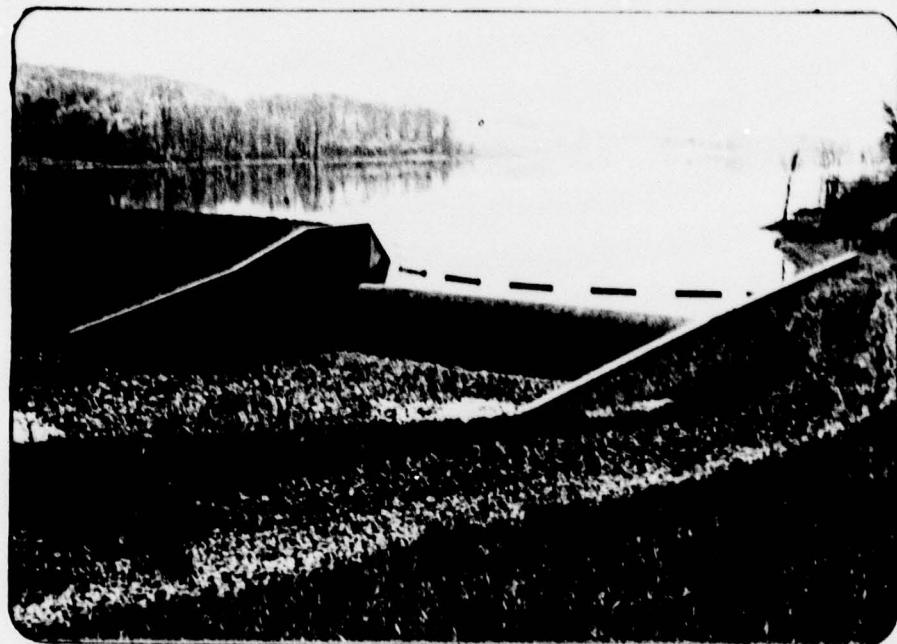
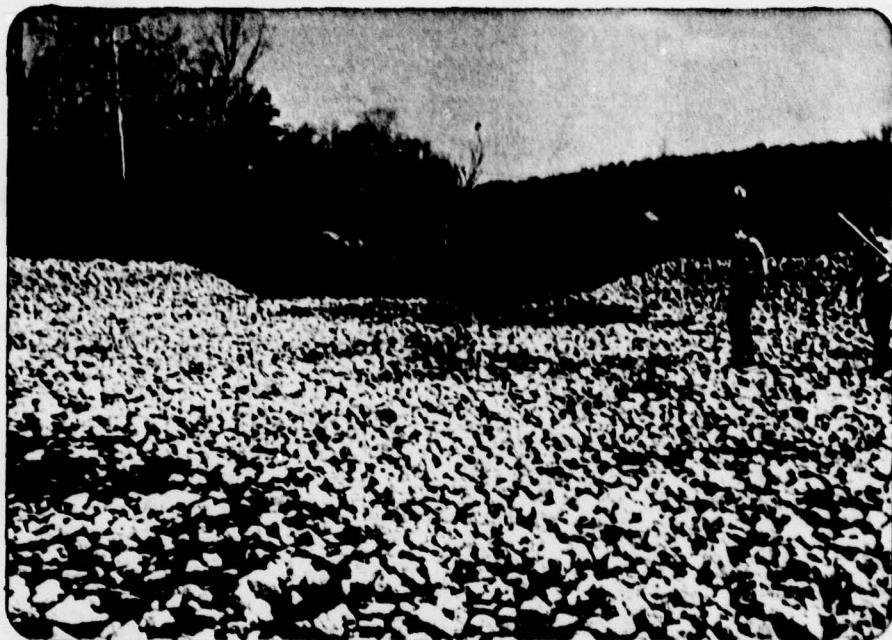


PHOTO 1. View of Spillway and Reservoir from Left Abutment Hillside



PHOTO 2. Close-up View of Spillway and Slotted Flip Bucket Energy Dissipater

**GLADES DAM**



**PHOTO 3. View Looking Downstream at Discharge Channel from Spillway**

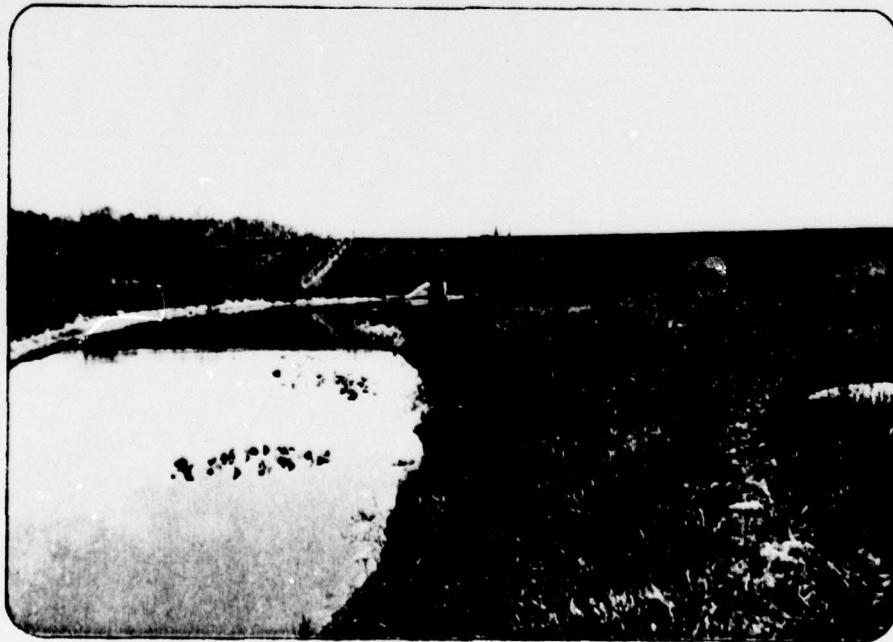


**PHOTO 4. View of Intake Control Tower**

**GLADES DAM**



**PHOTO 5. Close-up View of Three Foot by Five Foot Intake at El. 1197.0 feet**  
(The sluice gate was designed to be in the inverted position.)



**PHOTO 6. View of Downstream Embankment, Outlet Structure,  
and Discharge Channel for the Outlet Conduit**

**GLADES DAM**

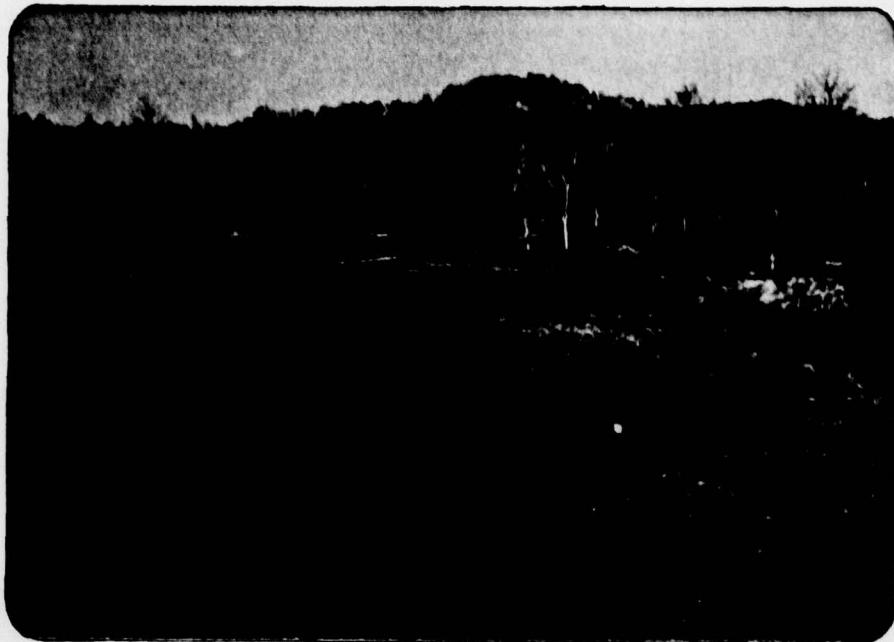


**PHOTO 7. Close-up View of Outlet Structure (Note: Backwash and erosion around wing walls)**



**PHOTO 8. View Looking Downstream at Discharge Channel for the Outlet Conduit**

**GLADES DAM**



**PHOTO 9. View of Downstream Area**



**PHOTO 10. View of Drainage Ditch on the Left Abutment of the Dam**

**GLADES DAM**



**PHOTO 11. View of One of Three Small Slides on the Left Side Slope  
of the Spillway Discharge Channel**



**PHOTO 12. View of Another Small Slide on the Left Side Slope  
of the Spillway Discharge Channel**

**APPENDIX D**

**HYDROLOGIC AND HYDRAULIC COMPUTATIONS**

MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Glades Dam S.O. No. \_\_\_\_\_  
Sheet No. \_\_\_\_\_ of \_\_\_\_\_  
Drawing No. \_\_\_\_\_  
Computed by \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

### Table of Contents

<u>SUBJECT</u>	<u>PAGE</u>
Preface	i
Rainfall and Hydrologic Data	1
Watershed Plan	2
Top of Dam Profile	3
stage vs. storage	4
Spillway Rating	5
Tailwater Rating	6
Location Plan	7
Computer Analysis	8

PREFACE

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic determinations presented in this Phase I Inspection Report are based on the use of a Snyder's unit hydrograph developed by the U.S. Army Corps of Engineers. Due to the limited number of gaging stations available in this hydrologic region and the wide variation of watershed slopes, the Snyder's coefficients may yield results of limited accuracy for this watershed. As directed however, a further refinement of these coefficients is beyond the scope of this Phase I Investigation.

In addition, the conclusions presented pertain to present conditions, and the effect of future development on the hydrology has not been considered.

**MICHAEL BAKER, JR., INC.**  
**THE BAKER ENGINEERS**

Box 280  
Beaver, Pa. 15009

Subject GLADES DAM S.O. No.     
RAINFALL & HYDROLOGIC DATA Sheet No. 1 of 12  
Drawing No.     
Computed by J. J. S. Checked by REH Date 3-21-79

RAINFALL DATA DRAINAGE AREA IS LOCATED IN ZONE 2 FOR HMR-33

$$PMP_{24\text{ HR.}} = 200 \text{ mi.} = 23.7 \text{ in.} \quad (DA = 21.97 \text{ mi.}^2)$$

P6HR = 107.76 PMP

$$P12 NR. = 117\% PNP$$

P 24 HR. = 130.90 PMP.

P 48 HR. = 140% PMP

HYDROLOGIC DATA DRAINAGE AREA IS LOCATED IN ZONE 27;  $C_P = 0.40$

CG = PLATE 0.5;  $\frac{t}{t_0} = 2.7 (L)^{0.6}$ ;  $t_0 = 20 \text{ MIN. or } 0.5 \text{ HR.}$

$$L = 322 \text{ mi}$$

$$\epsilon_D = 2.7(L)^{0.6} \cdot *$$

$$ED = 2.7(3.22)^{0.6}$$

$$EP = 5.45 \text{ HRS.}$$

$$\tau r = \tau D / 5.5$$

$$Er = 5.45 / 5.5$$

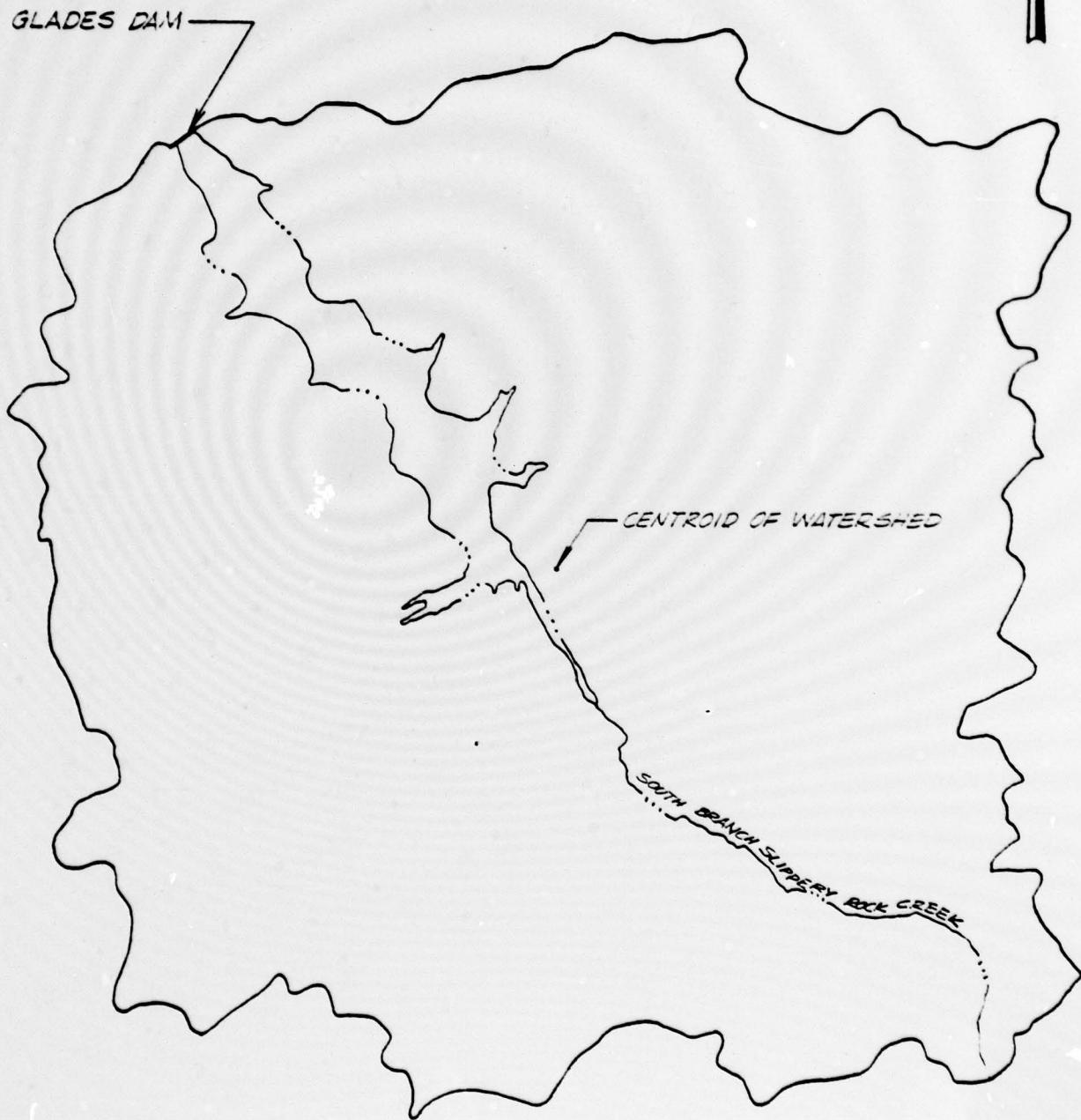
$$t_r = 0.99 \text{ HRS.}$$

$$t_{DR} = t_P + 0.25 (\epsilon_R - \epsilon_I)$$

$$tDR = 5.45 \pm 0.25 (0.5 - 0.99)$$

TPR = 5.33 HRS.

\* Since the centroid of the basin falls within the reservoir.



### GLADES DAM

DRAINAGE AREA MAP (21.97 SQ.MI.), LENGTH: 5.32 MI.

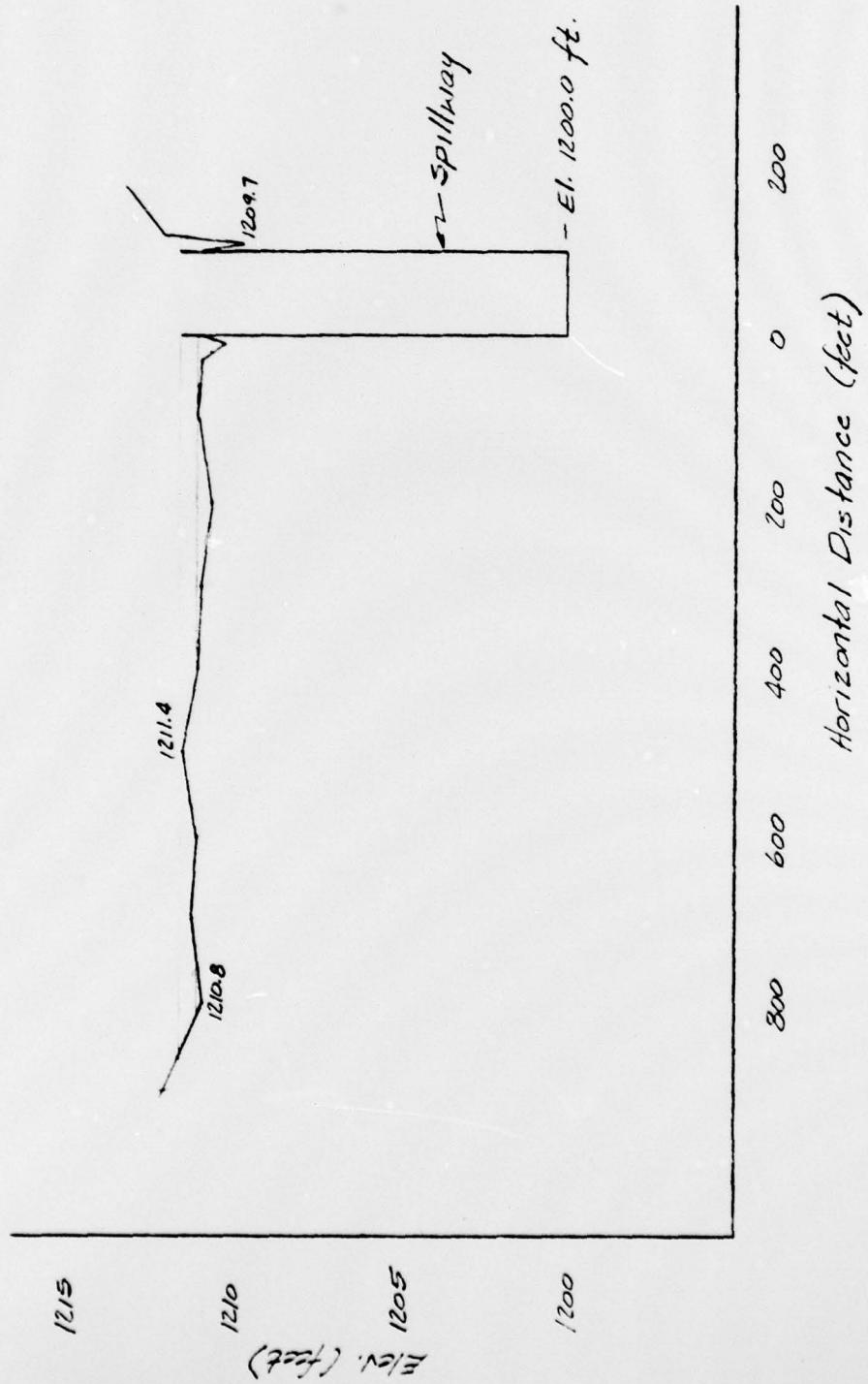
QUADS: W. SUNBURY, HILLIARDS, E. BUTLER, MOUNT CHESTNUT

4000 0 4000 5000  
SCALE IN FEET

MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

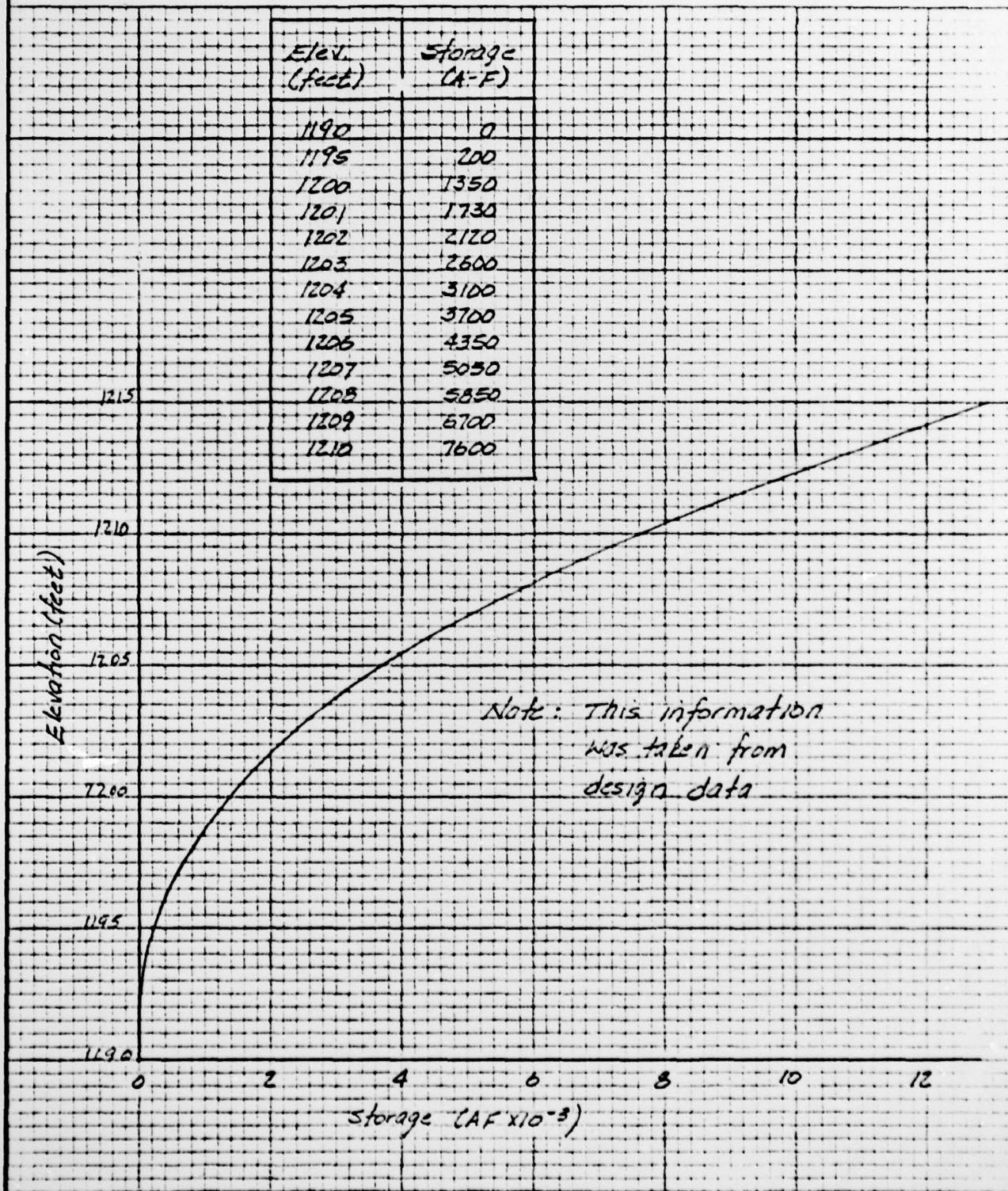
Subject Glades Dam S.O. No. \_\_\_\_\_  
Top of Dam Profile Sheet No. 3 of 12  
Computed by REH Drawing No. \_\_\_\_\_  
Checked by \_\_\_\_\_ Date \_\_\_\_\_



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

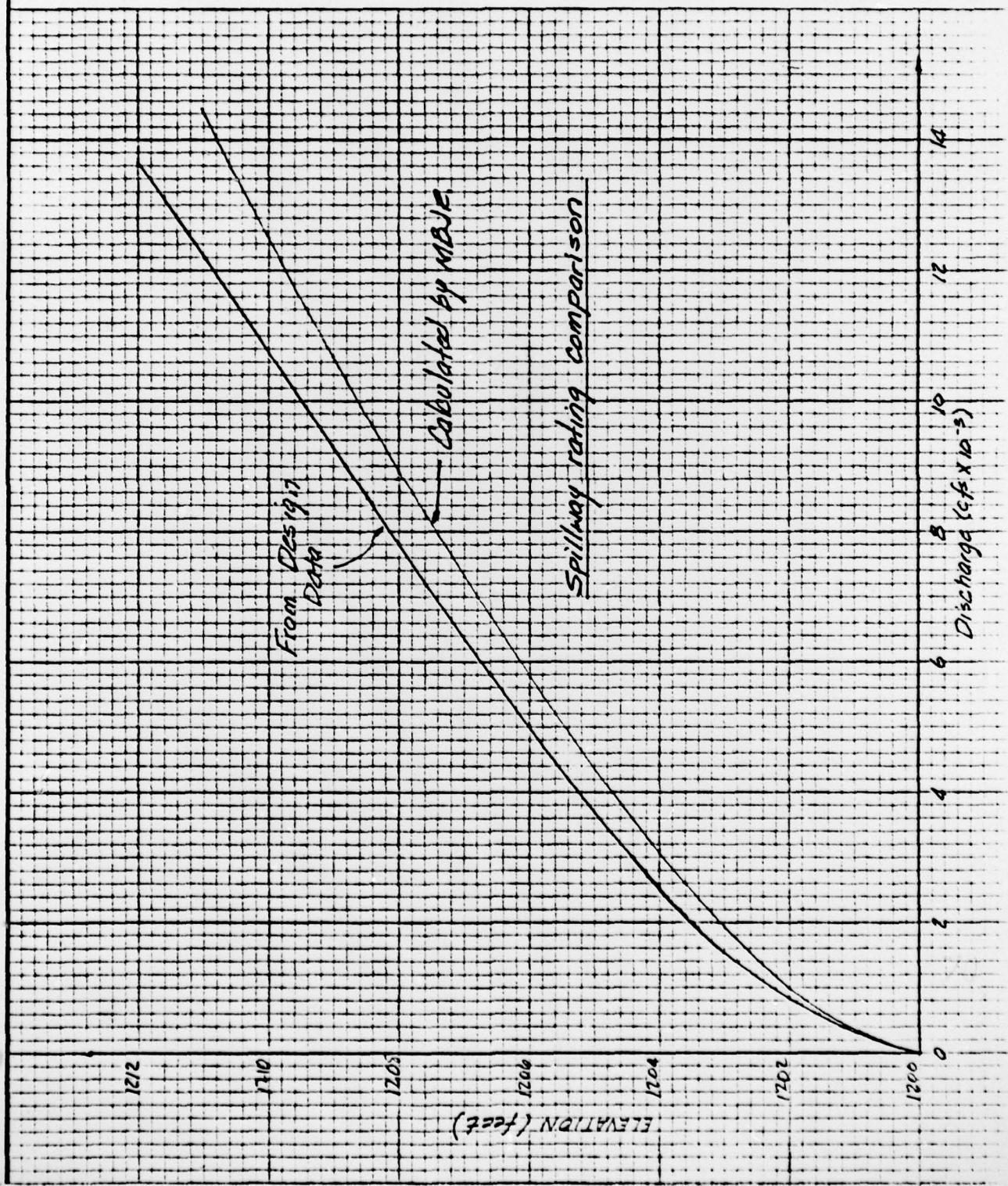
Subject Glades Dam S.O. No. \_\_\_\_\_  
Stage vs. Storage Sheet No. 4 of 12  
\_\_\_\_\_  
Computed by G.G.S. Checked by REH Drawing No. \_\_\_\_\_  
Date 3-21-79



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

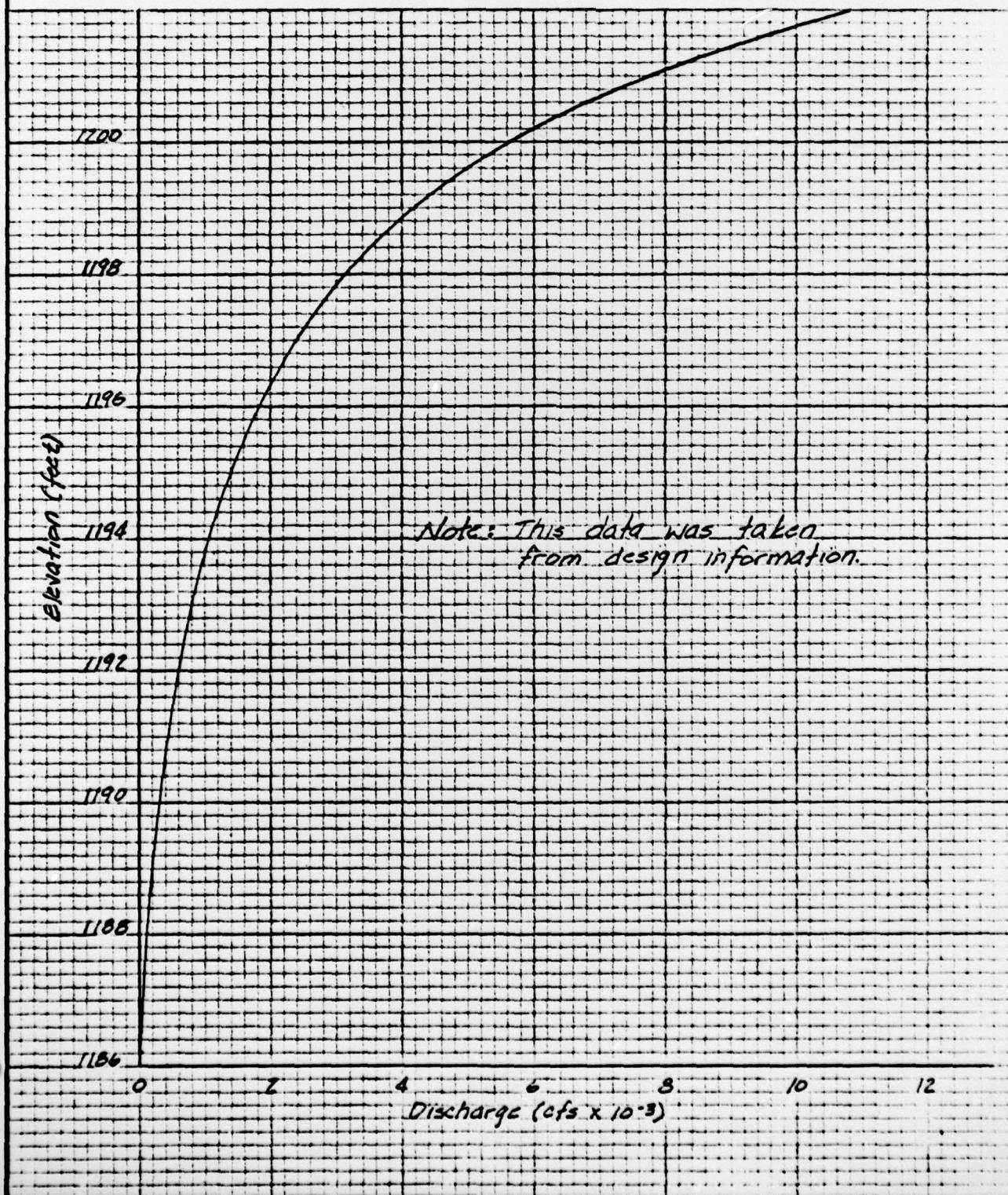
Subject Glades Dam S.O. No. \_\_\_\_\_  
Spillway Rating Sheet No. 5 of 12  
\_\_\_\_\_  
Computed by G. G. S. Checked by REH Drawing No. \_\_\_\_\_  
Date 3-21-79



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Glades Dam S.O. No. \_\_\_\_\_  
Tailwater Rating Sheet No. 6 of 12  
\_\_\_\_\_  
Computed by G.G.S. Checked by \_\_\_\_\_ Drawing No. \_\_\_\_\_  
Date 3-21-79



MICHAEL BAKER, JR., INC.  
THE BAKER ENGINEERS

Box 280  
Beaver, Pa. 15009

Subject Glades Dam

S.O. No.

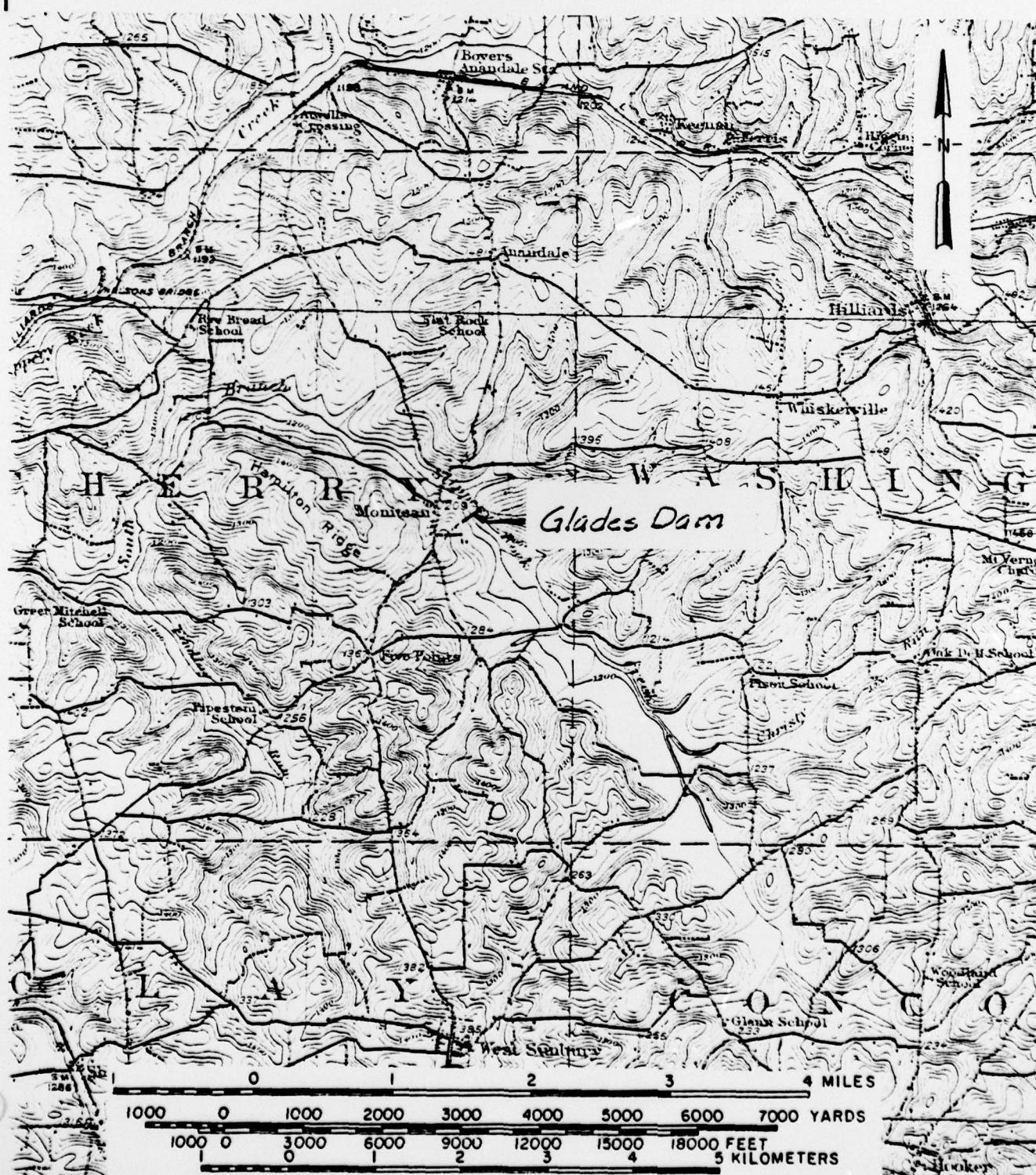
Map of Reservoir and  
Downstream Area

Sheet No. 7 of 12

Computed by REH

Checked by \_\_\_\_\_

Drawing No. \_\_\_\_\_  
Date 7-20-79



\*\*\*\*\*  
FLINDO HYDROGRAPH PACKAGE (HFC-11)  
DAM SAFETY VERSION 1  
LAST MODIFICATION 26 FEB 79  
MHA UPDATE 04 JUN 79  
\*\*\*\*\*

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS									
HYDROGRAPH PACKAGE (HEC-1)									
SAFETY VERIFICATION									
LAST MODIFICATION 26 JULY 1978									
MMH UPDATE 04 JUN 79									
1	41	NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS							
2	42	HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLADES DAM MBJ 22							
3	43	PROBABLE MAXIMUM FLOOD PROFILE HYDROGRAPH BY SNYDERS METHOD							
4	8	300	0	30	0	0	0	0	0
5	81	5	0	0	0	0	0	0	0
6	81	1	3	1	1	1	1	1	1
7	71	1.0	0.75	0.5	0.5	0.5	0.5	0.5	0.5
8	K1	0	1	1	1	1	1	1	1
9	K1	0	1	1	1	1	1	1	1
10	M	1	1	21.97	21.97	21.97	21.97	21.97	21.97
11	P	23.7	107	117	130	140	140	140	140
12	T	12	0.4	0.4	0.4	0.4	0.4	0.4	0.4
13	W	5.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4
14	X	-1.5	-0.05	2.0	2.0	2.0	2.0	2.0	2.0
15	K1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	K1	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	Y1	1	1	1	1	1	1	1	1
18	Y4	1200	1201	1202	1203	1204	1205	1206	1207
19	Y4	1210	1211	1212	1213	1214	1215	1216	1217
20	Y5	0	300	850	1550	2550	3700	5000	6350
21	Y5	10800	12200	13600	16200	2120	2600	3100	3700
22	SS	0	200	1350	1750	2120	2600	3100	3700
23	SS	0	200	1350	1750	2120	2600	3100	3700
24	SS	5850	6700	7600	8600	9700	10750	11800	12900
25	SE	1190	1195	1200	1201	1202	1203	1204	1205
26	SE	1208	1209	1210	1211	1212	1213	1214	1215
27	SS	1200	28	28	28	28	28	28	28
28	SD1209.7	0	7	21	470	880	925	925	925
29	SD1209.7	1210.2	1210.5	1211.0	1211.5	1212.0	1212.5	1212.5	1212.5
30	SD1209.7	1210.2	1210.5	1211.0	1211.5	1212.0	1212.5	1212.5	1212.5

Sheet 8 of 12

\*\*\*\*\*
FL110 HYDROGRAPHIC PACKAGE (HPC-11)
DAM SAFETY VERIFICATION JULY 1978
LAST MODIFICATION 26 FEB 79
43.1 UPDATE 04 JUN 79
\*\*\*\*\*

RUN DATE 07/18/79
TIME 19:23

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF GRADES DAM MBJ 22
PROBABLE MAXIMUM FLOOD PMF/UNIT GRAPH BY SNYDER'S METHOD

NU	NHR	NMIN	IDAY	JHR	IMIN	METR	IPLT	IPRT	INSTAN
300	0	30	0	0	0	J	0	-4	0
			JOPER	NMT	TRJPT	TRACE			
			5	0	J	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 3 LRTIO= 1
0.50

\*\*\*\*\*
\* \* \* \* \* SUB-AREA RUFFOFF COMPUTATION
\*\*\*\*\*

SNYDER'S UNIT HYDROGRAPH FOR SOUTH BRANCH OF SLIPPERY RUCK CREEK

ISTAQ	ICOMP	IECUN	ITAPE	JPLT	JPRT	INAME	ISAME	IAUTO
1	0	0	0	0	0	0	0	0

HYDROGRAPH DATA
TRSCPC KATIU ISNCW ISAME LCLAL

0.0 23.70 107.00 117.00 130.00 140.00 R72 R46

STOFF	PMS	P6	P12	R28	R43	R72	R46
0.0	21.97	0.0	21.97	0.0	0.0	0.0	0.0

PRECIP DATA
ISNCW ISAME LCLAL

0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0

UNIT HYDROGRAPH DATA
TP= 5.33 CP=0.44 NTAB= 0

STPTQ= -1.50 RFFCSSION DATA
QPCSN= -0.05 RTIUR= 2.00

UNIT HYDROGRAPH FOR PERIOD ORDINATES, LAG=	5.32 HOURS, CP= 0.40	VOL= 0.99
27. 102. 209. 338. 483. 637. 783. 905. 999.	865. 823. 783. 763. 746.	762. 709.
1084. 1056. 1005. 956. 909. 581. 552. 525. 500.	525. 500. 476. 452.	430.
674. 641. 610. 581. 552. 371. 353. 329. 319.	319. 290. 275. 261.	261.
410. 390. 371. 353. 329. 317. 290. 275. 261.	261. 244. 224. 214. 204.	204.
76. 72. 67. 62. 57. 52. 47. 42. 37.	37. 34. 31. 28. 25. 22. 19. 16. 13.	16. 13.

151.	144.	137.	130.	124.	118.	112.	107.	101.
92.	87.	83.	75.	66.	53.	41.	39.	36.
56.	53.	50.	48.	46.	43.	41.	39.	37.
34.	32.	31.	29.	26.	25.	24.	23.	22.
21.	20.	19.	18.	17.	16.	15.	14.	13.

0 0.03 HP-MIN PERIOD RAIN EROS LOSS FNU-OF-PERIOD FLOW MOUA HR-MIN PERIOD RAIN EROS LOSS CUMP 4

SUM 27.41 246.97 2.44 706935  
( 090.11 034.14 02.11 119501.57)

\*\*\*\*\*

HYDROGRAPH ROUTING

THIS IS A ROUTING FOR GLADES DAM

ISTAU DAM	ICOMP 1	IECIN 0	ITAPE 0	JPLT 0	JPTT 0	INAME 1	ISAGE 0	IAUTO 0
GLOSS 0.0	CLOSS 0.0	AVG 0.0	ROUTING DATA IRES ISAME 1	ROUTING DATA IPTT 0	IPMP 0	TSK 0.0	SIORA -1200.	ISPRAT -1
NSTPS 1	NSTOL 0	LAG 0.0	AMSKK 0.0	X	TSK 0.0	SIORA -1200.	ISPRAT -1	LSTR 0
STAF	1200.00	1201.00	1202.00	1203.00	1204.00	1205.00	1206.00	1207.00
FLW	1210.00	1211.00	1212.00					1208.00
CAPACITY=	0.	200.	1350.	1730.	2120.	2600.	3100.	3700.
EVAVATOR=	5850.	6700.	7600.	8600.	9700.	10750.	11800.	12900.
PEAK CURRENCE	1190.	1195.	1200.	1201.	1202.	1203.	1204.	1205.
	1208.	1209.	1210.	1211.	1212.	1213.	1214.	1215.
CFEL	1200.0	SP=10	CQW	EXPM	LEVEL	CDL	CAREA	EXPL
		0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOPEL	1209.7	CQD	EXPD	DAMID				
		0.0	0.0	0.0				

CREST LENGTH AT 0 MFLC4 ELEVATION

1209.7 AT TIME 51.00 HOURS

PEAK CURRENCE IS 14975. AT TIME 50.00 HOURS

PEAK CUFFLOW IS 7183. AT TIME 50.50 HOURS

Sheet 10 of 12

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

\*\*\*\*\*

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLANT-RATIO ECONOMIC COMPUTATIONS  
 FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)  
 AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO APPLIED TO FLOWS		
				RATIO 1 1.00	RATIO 2 0.75	RATIO 3 0.50
HYDROGRAPH AT	1	21.97	1	21652.	16269.	10866.
	(	56.901	(	614.251	460.691	307.131
UNLISTED TO	DAM	21.97	1	14975.	10639.	7183.
	(	56.901	(	424.661	301.261	203.411

## SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....	ELEVATION STOPPAGE CUFFLOW	INITIAL VALUE	SPILLWAY CREST	MINIMUM					
				MAXIMUM RESERVOIR W.S.ELFV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1211.70	2.00	9372.	14975.	14.00	20.00	1.0	1.0	1.0
0.75	1209.89	0.19	7503.	16639.	4.50	51.00	0.0	0.0	0.0
0.50	1207.57	0.0	5510.	7183.	0.0	50.00	0.0	0.0	0.0

**APPENDIX E**

**REGIONAL GEOLOGY**

GLADES DAM  
NDI No. PA 00804, PennDER No. 10-72

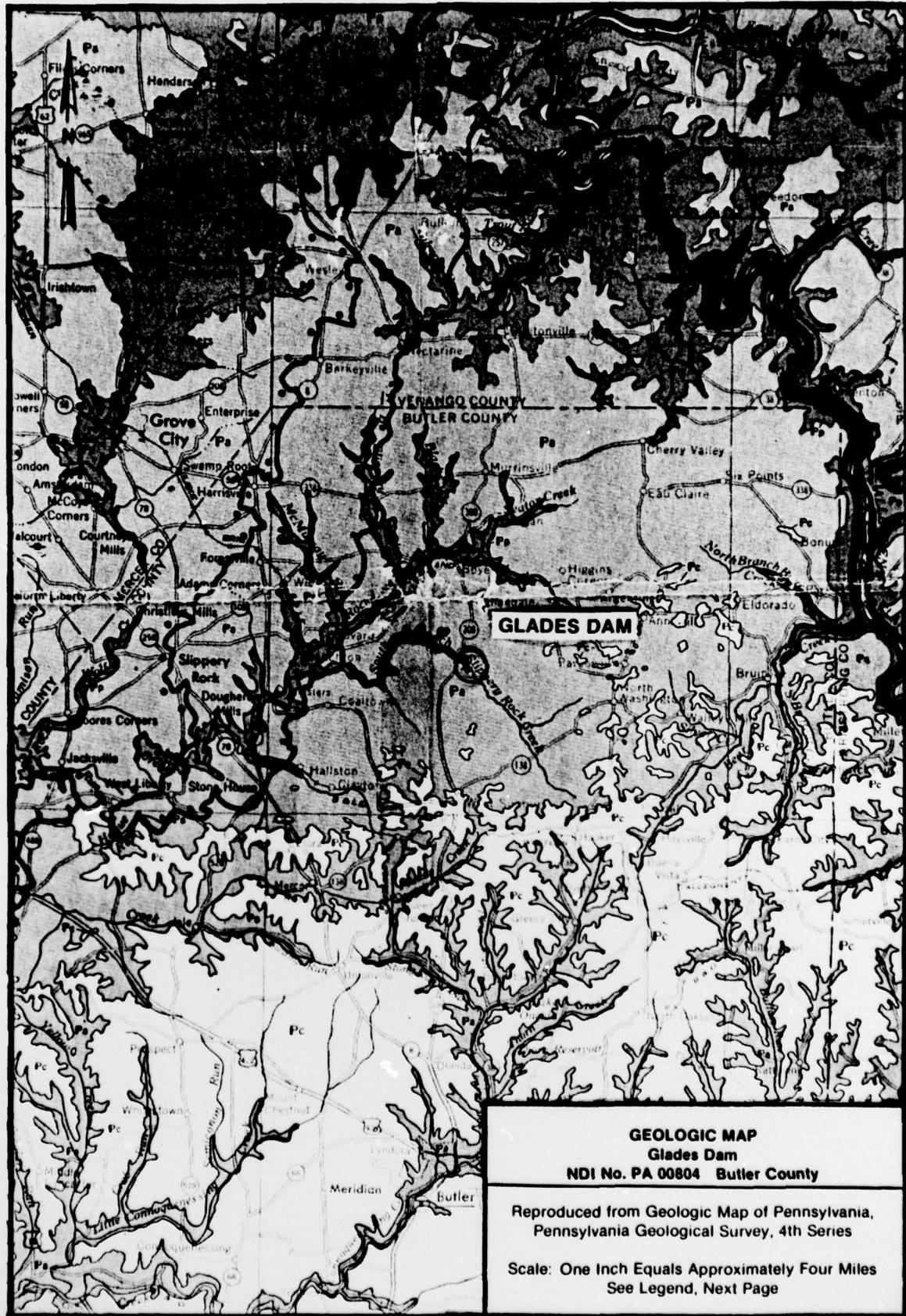
REGIONAL GEOLOGY

Glades Dam is located on the South Branch of Slippery Rock Creek in the Kanawha section of the Appalachian Plateaus Physiographic Province. Although the area has not been glaciated, the dam site is located approximately 3.5 miles east of the border of the Illinoian drift.

A design report for the dam describes the area as having relatively uniform foundation conditions. Beneath a one foot vegetative mat is a 15 foot deposit of brown and gray clayey silt, underlain by 30 feet of gray clay. Because the area is poorly drained, the water table is close to the surface. However, beneath the silt and clay deposits is a stratum of granular material which contains water under a high hydrostatic head; during design test drilling, the static head was measured at El. 1203 feet. This is 8 feet above the ground surface El. 1195 feet. It was concluded at that time, however, that no adverse effects would occur from this head since construction would not penetrate the granular stratum.

The soil deposits were possibly formed as the result of glacial impoundment of Slippery Rock Creek to the west.

As shown on the geologic map on the following page, the dam is located close to the contact between the Pottsville and Allegheny Formations, Pennsylvanian System. Bedrock dips gently to the southeast from the axis of the Harrisville Syncline. Rock units in the Pottsville Formation are typically sandstones and conglomerates, whereas the Allegheny consists of cyclic sequences of sandstone, shale, limestone, and coal. The Pottsville/Allegheny contact is marked by the Brookville coal. Two test borings on the left abutment, S-2 and S-3, penetrated coal at El. 1184.6 feet and El. 1183.3 feet respectively. This seam, possibly the Brookville, is between 0.5 and 1.4 feet thick and apparently pinches out within a short distance. The bedrock noted in the borings, in addition to the coal, is decomposed shale and sandy shale.



## PERMIAN

### Greene Formation

*Cyclic sequences of sandstone, shale, red beds, limestone and coal; base at the top of the Upper Washington Limestone.*

## PERMIAN AND PENNSYLVANIAN

### Washington Formation

*Cyclic sequences of sandstone, shale, limestone and coal; some red shale, some mineable coal; base at the top of the Waynesburg Coal.*

## PENNSYLVANIAN

### APPALACHIAN PLATEAU

#### Monongahela Formation

*Cyclic sequences of sandstone, shale, limestone and coal; limestone prominent in northern exterior areas; shale and sandstone increase southward; commercial coals present; base at the bottom of the Pittsburgh Coal.*

#### Conemaugh Formation

*Cyclic sequences of red and gray shales and dolomite with thin limestones and coals; massive Mahoning Sandstone commonly present at base; Ames Limestone present in middle of section; Brush Creek Limestone in lower part of section.*

#### Allegheny Group

*Cyclic sequences of sandstone, shale, limestone and coal; numerous commercial coals; limestone thicker westward; Vanport Limestone in lower part of section; includes Freeport, Aspinwall, and Clarion Formations.*

#### Pottsville Group

*Predominantly sandstones and conglomerates with thin shales and coals; some coals mineable locally.*

## ANTHRACITE REGION

#### Post-Pottsville Formations

*Brown or gray sandstones and shales with some conglomerate and numerous mineable coals.*

#### Pottsville Group

*Light gray to white, coarse grained sandstones and conglomerates with some mineable coal; includes Sharp, Mountain, Schuylkill, and Tumbling Run Formations.*

## MISSISSIPPIAN

### Mauch Chunk Formation

*Red shales with brown to greenish gray flaggy sandstones; includes Greenbrier Limestone in Fayette, Westmoreland, and Somerset counties; Logatonia Limestone at the base in southwestern Pennsylvania.*

### Pocono Group

*Predominantly gray, hard, massive, cross-bedded conglomerate and sandstone with some shale; includes in the Appalachian Plateau: Burgess, Shenango, Cuyahoga, Casselman, Corry, and Knapp Formations; includes part of "O�ong" of M. L. Fuller in Potter and Tioga counties.*